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KIMBALL (L ROBERT) AND ASSOCIATES EBENSBURG PA  
NATIONAL DAM SAFETY PROGRAM. CANNONVILLE DAM,  
JUL 78 R J KIMBALL

F/G 13/2  
INVENTORY NUMBER--ETC(U)  
DACW51-78-C-0025  
NL

UNCLASSIFIED

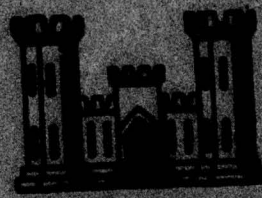
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ANNONSVILLE  
LAWARE COUNTY, NEW Y  
VENTORY NUMBER NY E

**HASE 1  
ISPECTION REP  
ATIONAL DAM  
AFETY PROGRA**



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**DELAWARE RIVER BASIN**

**CANNONSVILLE DAM**

**DELAWARE COUNTY, NEW YORK  
INVENTORY NUMBER NY 542**

**PHASE 1  
INSPECTION REPORT  
NATIONAL DAM  
SAFETY PROGRAM**



**DISTRIBUTION STATEMENT A**

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**Prepared by**

**L. ROBERT KIMBALL and ASSOCIATES  
615 W. Highland Ave. Ebensburg, Pa.**

**Prepared For**

**DEPARTMENT OF THE ARMY  
NEW YORK DISTRICT, CORPS OF ENGINEERS  
NEW YORK, NEW YORK**

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report Cannonsville Dam Delaware River Basin, Delaware County, N.Y. Inventory Number N.Y. 542		5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program
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18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety National Dam Safety Program Visual Inspection Hydrology, Structural Stability Delaware County West Branch Delaware River		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Cannonsville Dam was judged to be in good condition, although further anal- ysis should be undertaken.		

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

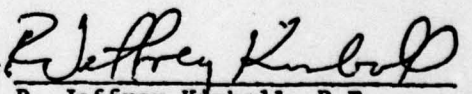
Name of Dam: Cannonsville Dam  
State of Dam: New York  
County Located: Delaware  
Stream: West Branch Delaware River  
Date of Inspection: June 13, 1978

ASSESSMENT

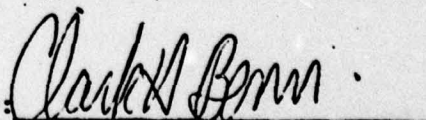
The inspection and evaluation of the Cannonsville Dam did not reveal any problems which require immediate action. In general the dam is in excellent condition. However, a review of available soils data and embankment stability analysis should be conducted by the owner according to current criteria.

The hydrologic analysis indicated that the emergency spillway is capable of passing the PMF.

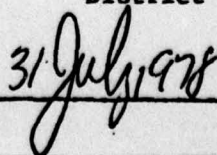
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R. Jeffrey Kimball, P.E.  
L. ROBERT KIMBALL & ASSOCIATES  
Registration No. PA 26275E

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Colonel, Corps of Engineers  
District Engineer

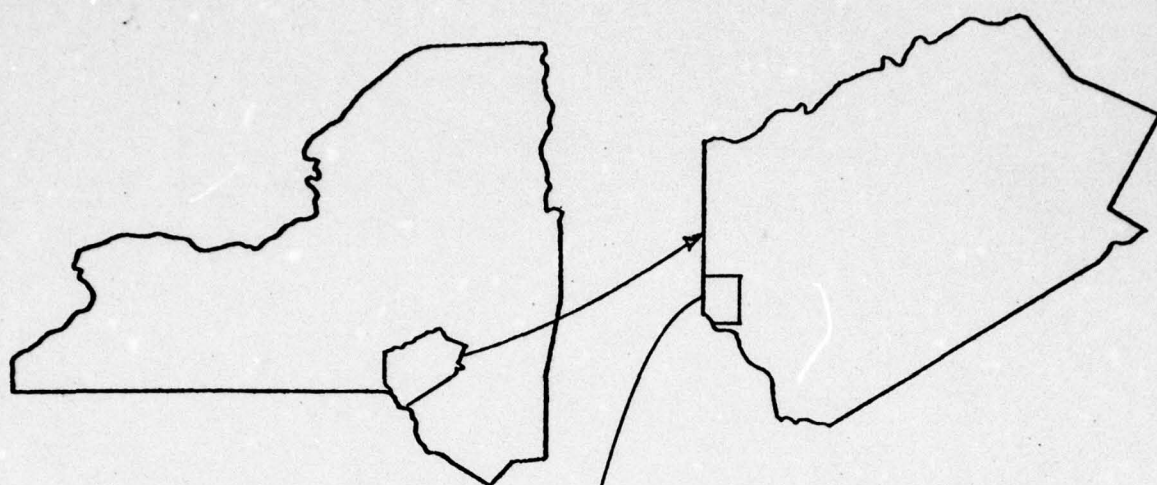
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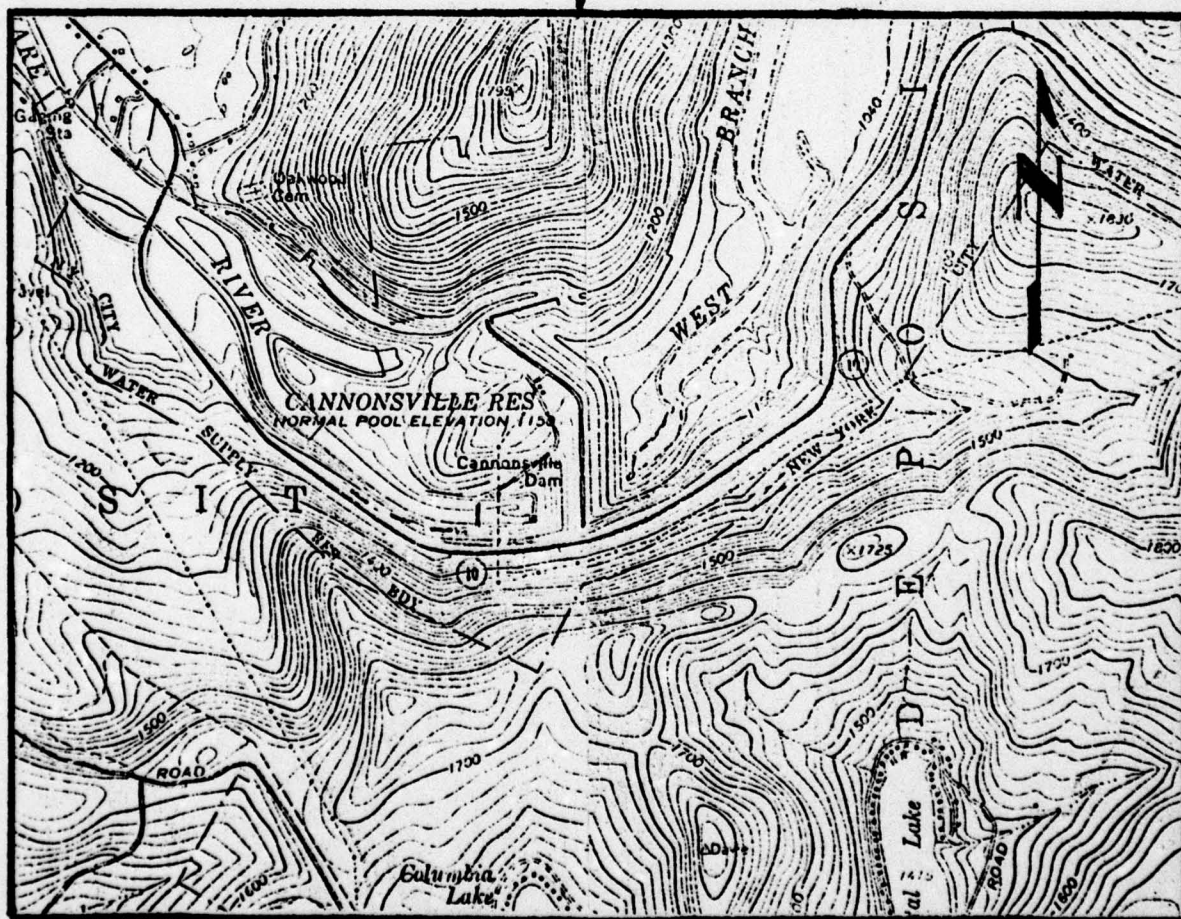
OVERVIEW OF DOWNSTREAM  
SLOPE AND OUTLET STRUCTURE





NEW YORK

DELAWARE COUNTY



Portion of Deposit and Cannonsville U.S.G.S. 7.5 minute quadrangles

**CANNONSVILLE DAM**

**SITE LOCATION MAP**

SCALE : 1" = 2000'

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
CANNONSVILLE DAM ID # 542

SECTION 1: PROJECT INFORMATION

1.1 General:

- a. Authority: Authority is provided by the National Dam Inspection Act Public Law 92-367.  
Contract Number: DACW51-78-C-0025
- b. Purpose of Project: Evaluation of non-Federal dams to identify dams which are a threat to life or property.

1.2 Description of Project:

- a. Description of Dam and Appurtenances: The Cannonsville Dam is a zoned earthfill embankment with a height of 175 feet. The dam is formed by two embankment sections. The left abutment section is the main embankment blocking the main river channel. The right section a low embankment constructed over a topographic saddle or low ridge. The embankment section varies with slopes from 2:1 to 3:1 with slope benches at various sections.

The emergency spillway is located at the right abutment. The spillway is a side channel spillway. The overflow weir is a two section spillway with a total length of 800 feet. The lower section at elevation 1,150 is 240 feet long. The upper section (right section) at elevation 1158.07 is 560 feet long. The left section is an ogee type weir, the right a broad-crested weir. Spillway capacity is approximately 200,000 cfs.

The overflow weir discharges to a side channel excavated in rock at the right abutment.

The principal spillway intake is a concrete tower at the left abutment. The outlet pipe is a 11'11" diameter concrete conduit which conveys flow to the downstream toe control gate house. Five various size pipes and mechanical gates control discharge from the gate house.

- b. Location: The dam is located in Delaware County east of Deposit, New York on the West branch of the Delaware River. The location of the dam and reservoir can be found on the Deposit and Cannonsville Reservoir, New York 7.5 minute series U.S.G.S. quadrangles (see site location map).
- c. Size Classification: The dam is a large size structure.
- d. Hazard Potential: Cannonsville Dam is a high hazard potential structure.
- e. Ownership: The dam is owned by the city of New York, City Water Supply.



f. Purpose of Dam: The dam is used as a reservoir for the New York City Water Supply System.

g. Design and Construction History: The dam was designed by New York City Engineers. Noted soils engineers Terzaghi and Casagrande reportedly served as consultants on this project. Construction was completed in 1964.

Detailed design drawing are available for the dam.

h. Normal Operating Procedures: Under normal conditions water is discharged to the water supply.

Discharge to the downstream river is also required on an as needed basis.

Maintenance is performed by city staff located at the dam.

### 1.3 Pertinent Data:

a. Drainage Area: The drainage area is recorded as 450 square miles. The watershed is primarily wooded hillside.

b. Discharge at Damsite:

Maximum flood at damsite: August 1972, 5.72 feet over spillway; 12,500 cfs.

Total Spillway capacity at maximum design pool elevation: Approximately 200,000 cfs (elevation 1171.5) from design information (calculated 181,456 cfs).

Principal spillway capacity at pool elevation : 2,400 cfs

Principal spillway capacity at maximum pool elevation: 2,600 cfs

c. Elevation: (feet above MSL)

Top of Dam: 1,175.0

Maximum Pool Design Surcharge: 1,171.5

Emergency Spillway crest: Lower 1,150.0, upper 1,158.07

Stream bed at centerline of dam: 1,000.0

Maximum tailwater: Estimated 1,010.0

Upstream invert principal spillway: 1,007.24

Downstream invert principal spillway: 1,000.5

d. Reservoir:

Length of normal pool: 69,000 feet

Length of maximum pool: 73,000 feet

e. Storage: (acre-feet)

Normal pool: 300,999

Design surcharge: 411,488

Top of Dam: 450,000

f. Reservoir Surface: (acres)

Top of Dam: 6,100

Normal pool: 4,800

g. Dam:

Type: Zoned earth embankment

Length: 2,800'

Height: 175'

Top Width: 45'

Side slopes: Variable: Upstream: 1.5:1 to 3:1  
Downstream: 2.5:1 to 3:1

Zoning: Central core with upstream and downstream semi-pervious and rock embankments.

Impervious Core: Clay core

Cutoff: None

Grout Curtain: None

h. Diversion and Regulating Tunnel: Principal Spillway

Type: 11'-11" concrete conduit through dam into 5 discharge pipes

Length: 1,350 feet

Closure: Valvehouse at toe of dam and emergency gates at intake house upstream.

Access: Easy access to gates at crest and toe.

Regulating Facilities: Flow is regulated in valve house at toe



i. Spillway:

	<u>Spillway Weir</u>	<u>Side Channel</u>
Type:	Split level weir ogee and broad crested	Open channel excavated in rock
Length:	Total 800' (240' & 560')	1,850 feet
Crest Elevation:	1,150 & 1,158.07	Variable
Gates:	None	None
Upstream Channel:	None	None
Downstream Channel:	Vertical drop to side channel	Sloped rock and concrete channel to West Branch of Delaware River

j. Regulating Outlets: Water supply tunnel and principal spillway

## SECTION 2: ENGINEERING DATA

- 2.1 Design: Detailed construction drawings were available for review. Information on soils and hydrology was not available during our pre-inspection data collection or during the inspection.
- 2.2 Construction: No information was made available on the construction history other than the construction drawings and in discussions with the New York City Water Supply Staff.
- 2.3 Operation: Daily discharge and monthly maintenance records are kept.
- 2.4 Evaluation: The information which was available appears to be adequate to perform this study. Detailed information on soils, geology, and stability was not available for our review.



### SECTION 3: VISUAL INSPECTION

#### 3.1 Findings:

- a. General: Cannonsville Dam was inspected by personnel of L. Robert Kimball and Associates accompanied by city staff members on June 13, 1977.
- b. Dam: The dam appears to conform closely to the design drawings. The dam is well maintained and in good condition.  
  
The embankment slope at the right abutment had a few small wet areas possibly influenced by hillside springs and surface drainage
- c. Appurtenant Structures: The principal and emergency spillways appeared to be in good condition.
- d. Reservoir Area: The reservoir area is heavily wooded and appeared to be stable.
- e. Downstream Channel: The downstream channel is the West Branch of the Delaware River. The river is a wide channel meandering through Stilesville and Deposit, New York.

- 3.2 Evaluation: The visual inspection did not reveal any signs that would raise a cause for immediate concern.

#### SECTION 4: OPERATIONAL PROCEDURES

- 4.1 Procedure: New York City Water Supply keeps a superintendent and a staff of ten to perform all maintenance on the dam and appurtenant structures.
- 4.2 Maintenance of Dam: No planned maintenance schedule is utilized. However, the staff is constantly on the project and the grass is mowed biweekly in season. Maintenance is apparently performed as needed.
- 4.3 Maintenance of Operating Facilities: A monthly maintenance schedule is closely followed for the operating equipment particularly the valves on the spillway gates.
- 4.4 Description of Any Warning System: None in effect.
- 4.5 Evaluation: The maintenance programs for the dam and operating facilities appears adequate. However, it is recommended that a monthly inspection program be developed to be performed by New York City Water Supply personnel. In addition, a warning and evacuation plan should be developed.



## SECTION 5: HYDRAULIC/HYDROLOGIC

### 5.1 Hydrologic Evaluation of Features:

- a. Design Data: Design data was not made available for our review.
- b. Experience Record: The maximum discharge of memory occurred in August 1972, 5.72 feet over the low spillway.

A rain gage is located at the dam and a U.S.G.S. gaging station is located downstream.

- c. Visual Observations: At the time of our inspection approximately 0.5 feet of water was flowing over the emergency spillway.

The spillway weir, side channel, and exit channel appeared to be in good condition. It appeared that the spillway weir would be the controlling discharge structure. The side channel is wide and deep probably allowing free spillway weir flow.

- d. Overtopping Potential: Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF through the reservoir system. The PMF is that hypothetical flow induced by the most critical combination of precipitation, minimum infiltration losses, and concentration of run-off at a specific location, that is considered reasonably possible for a particular drainage area.

The drainage area contributing to Cannonsville Reservoir is approximately 450 square miles. To develop the basic hydrologic working tool, the unit hydrograph, Snyder Coefficients were used. To establish equations for determining Snyder Coefficients, personnel from the Hydrology Division of the New York District Corps of Engineers were contacted. Using assumed average value for  $C_T = 2$ , a value of  $T_p = 20.6$  was calculated considering watershed characteristics. Also, an average value of  $C_p = 0.6$  was assumed.

Using Hydrometeorological Report No. 33, the PMP index rainfall was determined to be 22.0 inches for a 24 hour duration, 200 square mile basin. The percentages of the index rainfall applied to other durations were interpolated from the plot of drainage area versus percent of 24 hour, 200 square mile. The computed PMF peak flow was 121,000 CFS. Routing the PMF through the impounded storage reduced the peak flow by 15,000 CFS. A plot of the PMF inflow and outflow hydrographs is included in the Appendix.

The ability of the Cannonsville Reservoir Dam to discharge the standard project flood (SPF) was also evaluated. The SPF peak flow of 45,000 CFS was routed through the reservoir. The SPF

outflow is indicative of a pool elevation of 1159.6 feet above MSL. This allows for 15.4' of freeboard remaining to the top of the dam.

The PMF outflow is indicative of a pool elevation of 1166.5 feet above MSL allowing for 8.5 feet of freeboard remaining.

To allow inflow and outflow hydrographs to be developed and routed, the following assumptions were made:

1. Discharge values for the spillway obtained from the owner were assumed to be correct. Weir coefficients were calculated from this data and weir flows extrapolated for higher level values.
2. No submergence of the side channel is anticipated. This was checked by calculating the critical depth in the channel.

#### SUMMARY OF HYDROLOGIC ANALYSIS CANNONSVILLE RESERVOIR

Elevation Top of Dam = 1175.0'

Elevation Ogee Weir Spillway = 1150.0'

Elevation Broad Crested Weir Spillway = 1158.07'

#### PMF ROUTING

PMF Peak = 121,000 CFS

PMF After Routing through Reservoir = 106,000 CFS

Elevation of Routed PMF corresponding to 106,000 CFS = 1166.5 feet above MSL

Freeboard remaining = 8.5 feet

Spillway surcharge = 16.5 feet

#### SPF ROUTING

SPF Peak = 45,000 CFS

SPF After Routing through Reservoir = 31,000 CFS

Elevation of Routed SPF corresponding to 31,000 CFS = 1159.6 feet above MSL

Freeboard remaining = 15.4 feet

Spillway surcharge = 9.6 feet



## SECTION 6: STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability:

- a. Visual Observations: Based on our visual inspection the dam appears to be well constructed according to the design plans. No distress was noted in the embankment.
- b. Design and Construction Data: No information on construction or stability calculations were available for review. Some data is apparently in city storage.
- c. Operating Records: The dam is operated in a manner which will not adversely affect stability.
- d. Post-construction Changes: No post-construction changes have been made which would influence the structural stability.
- e. Seismic Stability: The dam is located in seismic zone 1 and should not present any problems unless static conditions are unfavorable.

## SECTION 7: ASSESSMENT/REMEDIAL MEASURES

### 7.1 Dam Assessment:

- a. Safety: Based on our visual observation the dam does not appear to present a threat to life and property.
- b. Adequacy of Information: The information which was available to us was not adequate to conduct a complete evaluation of the dam.
- c. Urgency: No emergency or future action is necessary for this structure.
- d. Necessity for Future Studies: Formal, detailed study is not deemed necessary. A review of embankment stability should be completed by the owner to determine whether the embankment meets current state-of-the-art criteria.

### 7.2 Recommendations:

- a. A review of soils and stability analysis data should be completed by the owners or their consultant.
- b. A formal surveillance program should be established and followed for the structure.
- c. The owner should continue his excellent maintenance program.



**APPENDIX A**

**GEOLOGY**

### Cannonsville Dam

Cannonsville Reservoir is located in the Catskill "foot-hills." The bed-rock in this area is part of the Walton Formation of the Sonyea Group, which is Upper Devonian age. This stratum is interbedded dark siltstones and red silt and sandstones. This is the result of continuous deposition at a time of fluctuating shoreline. Red-beds are from oxidized terrestrial sediments while dark horizons were deposited in a marine reducing environment. These siltstones are durable and probably make a good foundation base. This is illustrated by the existence of an old gorge where the dam exists today.

The Pleistocene ice sheets have enlarged the preglacial valley to its present size. During the retreat of the ice sheets the Cannonsville Reservoir valley was partially filled with drift and outwash. This material is both sorted and unsorted. Downstream from the dam are several gravel pits.

**APPENDIX B**  
**HYDROLOGIC COMPUTATIONS**



L. ROBERT KIMBALL  
Consulting Engineers

SUBJECT \_\_\_\_\_

BY \_\_\_\_\_ DATE \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

JOB NO. \_\_\_\_\_

CANNONSVILLE

DRAINAGE AREA

AREA = 450 SQ. MI.

PRECIPITATION: FROM HYDROMETEOROLOGICAL REPORT No. 33

PMP INDEX = 22"

% OF DEPTH-AREA DURATION

6 HR. - 64%

12 HR. - 73%

24 HR. - 89%

48 HR. - 95%

SNYDER COEFFICIENTS

LENGTH OF MAIN DRAINAGE PATH, L

L = 60 MI

LENGTH ALONG MAIN DRAINAGE PATH FROM  
CENTER OF GRAVITY

$L_{CG} = 0.6L$   
= 36 MI

1111

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Consulting Engineers

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BY \_\_\_\_\_ DATE \_\_\_\_\_

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CANNONSVILLE

$$\begin{aligned} T_{PR} &= C(1.955)[L_1 L_2]^3 + .25 T_P \\ &= 2.0(1.955)(60 \times 36)^3 + .25(6) \\ &= 20.6 \text{ HR} \end{aligned}$$

$$\begin{aligned} Q_{PR} &= \frac{640 C_P A}{T_{PR}} \\ &= \frac{640(6)(450)}{20.6} \\ &= 8388 \text{ CFS} \end{aligned}$$

$$SPS = (9.5)(.92) = 8.74''$$



CANNONSVILLE

ELEVATION - DISCHARGE RELATIONSHIPS

LOW SPILLWAY:

$$Q = CLH^{3/2}$$

Assume:

$$C = 3.3$$

$$L = 240'$$

TOP SPILLWAY:

$$Q = CLH^{3/2}$$

Assume:

$$C = 3.2$$

$$L = 570'$$

OVERTOP:

$$Q = CLH^{3/2}$$

Assume:

$$C = 2.8$$

$$L = 2500'$$



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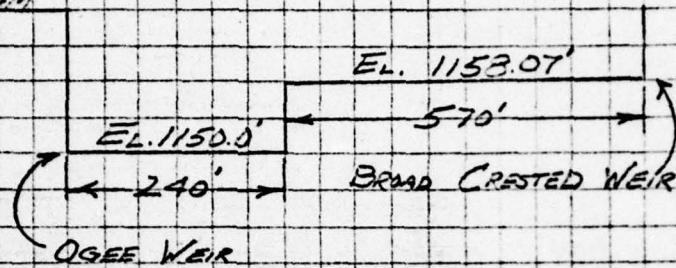
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# CANNONSVILLE

## ELEVATION - DISCHARGE RELATIONSHIP

TOP OF DAM  
EL. 1175.0'



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ELEV. FT.	LOW SPILLWAY		TOP SPILLWAY		OVER TOP		TOTALS
	H FT	Q CFS	H FT	Q CFS	H FT	Q CFS	Q CFS
1150	0	0	—	—	—	—	0
1151	1.0	912	—	—	—	—	912
1152	2.0	2530	—	—	—	—	2530
1153	3.0	4739	—	—	—	—	4739
1154	4.0	7296	—	—	—	—	7296
1155	5.0	10,196	—	—	—	—	10,196
1156	6.0	13,404	—	—	—	—	13,404
1157	7.0	16,890	—	—	—	—	16,890
1158	8.0	20,636	0	0	—	—	20,636
1159	9.0	24,624	1.0	1824	—	—	26,448
1160	10.0	28,840	2.0	5159	—	—	33,999
1161	11.0	33,272	3.0	9478	—	—	42,750
1162	12.0	37,911	4.0	14,592	—	—	52,503
1163	13.0	42,747	5.0	20,393	—	—	63,140

2000

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CANYONVILLE

ELEVATION - DISCHARGE RELATIONSHIP

ELEV FT	LOW SPILLWAY		TOP SPILLWAY		OVERTOP		TOTALS
	H FT	Q CFS	H FT	Q CFS	H FT	Q CFS	Q CFS
1164	14.0	47,773	6.0	26,807	—	—	74,580
1165	15.0	52,982	7.0	33,781	—	—	86,763
1166	16.0	58,368	8.0	41,272	—	—	99,640
1167	17.0	63,925	9.0	49,248	—	—	113,173
1168	18.0	69,647	10.0	57,680	—	—	127,327
1169	19.0	75,531	11.0	66,544	—	—	142,075
1170	20.0	81,572	12.0	75,822	—	—	157,394
1171	21.0	87,765	13.0	85,495	—	—	173,260
1172	22.0	94,108	14.0	95,547	—	—	189,655
1173	23.0	100,597	15.0	105,965	—	—	206,562
1174	24.0	107,229	16.0	116,736	—	—	223,965
1175	25.0	114,000	17.0	127,849	0	0	241,849
1176	26.0	120,910	18.0	139,294	1.0	8120	268,324
1177	27.0	127,950	19.0	151,062	2.0	22,967	301,979
1178	28.0	135,124	20.0	163,144	3.0	42,193	340,461
1179	29.0	142,427	21.0	175,531	4.0	44,960	382,918
1180	30.0	149,857	22.0	188,217	5.0	90,784	428,858

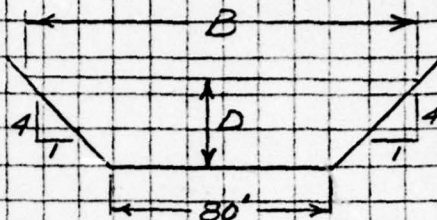
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TOP OF DAM: ELEV 1175.0'



CANYONVILLE

SIDE CHANNEL:



TO SEE IF SIDE CHANNEL WILL BE SUBMERGED, FIND CRITICAL DEPTH,  $D_c$ , FOR  $Q = 200,000$  CFS. THEN ADD  $D_c$  TO 1092, WHICH IS THE ELEVATION OF A SILL IN THE CHANNEL WHERE CRITICAL DEPTH MAY OCCUR. IF  $D_c + 1092' \ll 1150$ , NO SUBMERGENCE ANTICIPATED.

$$Q^2 B = g A^3$$

FROM DIAGRAM:  $B = 80 + D/2$

$$A = 80D + D^2$$

$$(200,000)^2 (80 + D/2) = 32.2 (80D + D^2)^3$$

SOLVING,  $D_c = 41.2'$

THEREFORE,

$$1092 + 41.2 = 1133.2' \ll 1150'$$

$\therefore$  NO SUBMERGENCE ANTICIPATED



0024

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Consulting Engineers

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CANNONSVILLEELEVATION - STORAGE RELATIONSHIP

ELEV. FT	SURFACE AREA ACRES	ΔELEV. FT	TOTAL STORAGE AC-FT	TOTAL DISCHARGE
1150	4764		0	0
		1.0		
1151	4807		4786	912
		1.0		
1152	4851		9614	2580
		1.0		
1153	4894		14,487	4739
		1.0		
1154	4938		19,403	7296
		1.0		
1155	4981		24,362	10,196
		1.0		
1156	5024		29,365	13,404
		1.0		
1157	5068		34,411	16,890
		1.0		
1158	5111		39,500	20,636
		1.0		
1159	5155		44,634	26,448
		1.0		
1160	5198		49,810	33,999
		1.0		
1161	5256		55,037	42,750
		1.0		
1162	5314		60,322	52,503
		1.0		
1163	5372		65,665	63,140
		1.0		
1164	5429		71,066	74,580
		1.0		
1165	5487		76,524	86,763
		1.0		

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L. ROBERT KIMBALL  
Consulting Engineer

SUBJECT \_\_\_\_\_

BY \_\_\_\_\_ DATE \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

JOB NO. \_\_\_\_\_

CANNONVILLE

ELEVATION - STORAGE RELATIONSHIP

ELEV. FT.	SURGE AREA	Δ ELEV.	TOTAL STORAGE	TOTAL DISCHARGE
1166	5545	1.0	82,040	99,640
1167	5633	1.0	87,614	113,173
1168	5661	1.0	93,246	127,327
1169	5719	1.0	98,936	142,075
1170	5777	1.0	104,684	157,394
1171	5834	1.0	110,489	173,260
1172	5892	1.0	116,352	189,655
1173	5950	1.0	122,273	206,562
1174	6008	1.0	128,252	223,965
1175	6066	1.0	134,289	241,849
1176	6124	1.0	140,354	260,324
1177	6182	1.0	146,507	301,979
1178	6239	1.0	152,718	340,461
1179	6297	1.0	158,986	382,918
1180	6355		165,312	428,858

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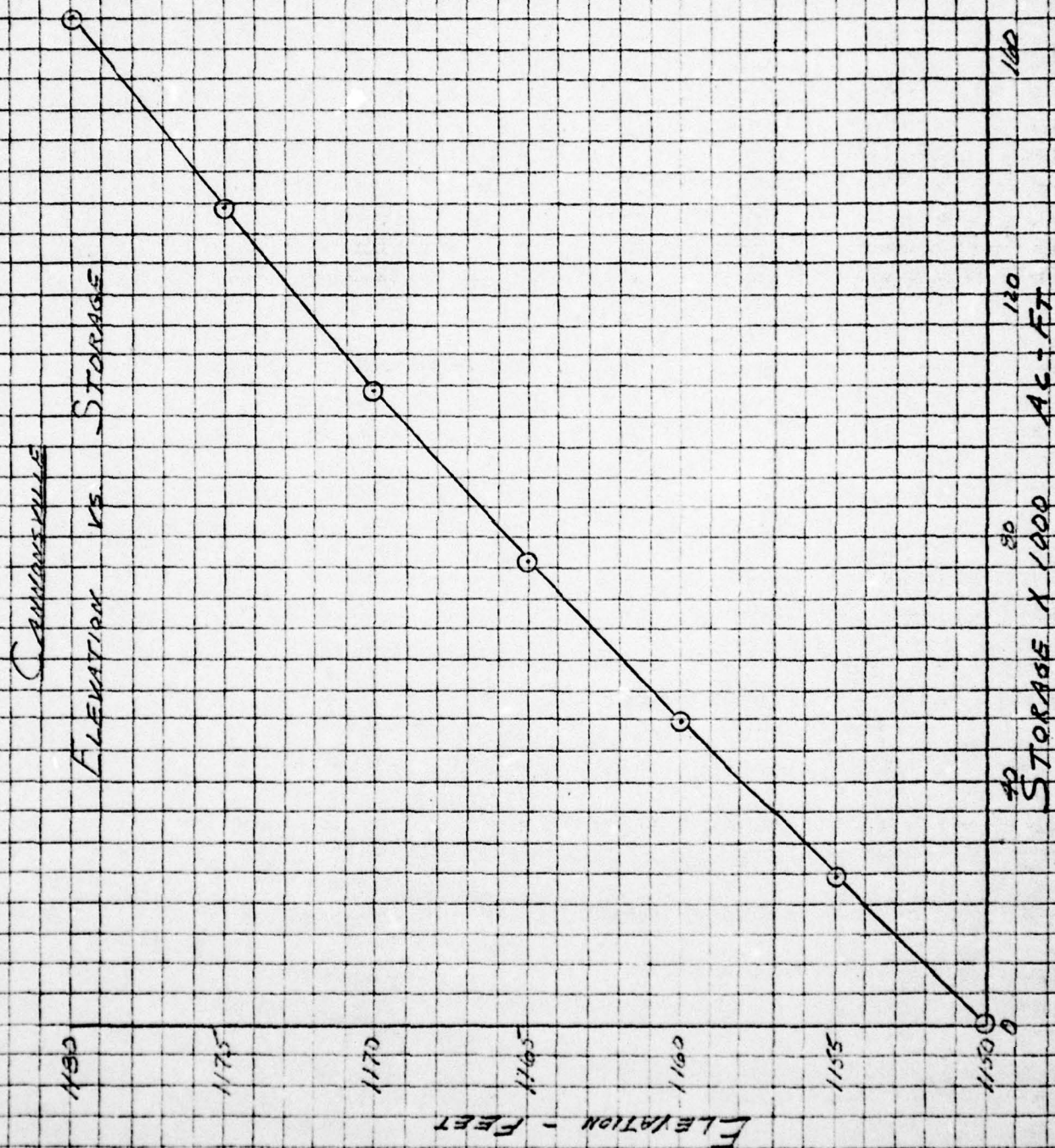


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L. ROBERT KIMBALL  
Consulting Engineers

SUBJECT \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

BY \_\_\_\_\_ DATE \_\_\_\_\_  
SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
JOB NO. \_\_\_\_\_



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\*\*\*\*\*  
 REC-1 VERSION DATED JAN 1973  
 UPDATED AUG 74  
 CHANGE NO. 01  
 \*\*\*\*\*

CANNONSVILLE RESERVOIR  
 NEW YORK CITY WATER SUPPLY  
 TEST PMP

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JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	ININ	MEIRC	IPLI	IPRT	ISTAN.
30	6	0	0	0	0	0	2	0	0

JOPER	NMT
3	0

\*\*\*\*\*

SUB-AREA RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLI	JPRT	ISAME	LOCAL
1	0	0	0	0	0	0	0

HYDROGRAPH DATA

IRVDS	IRVGS	JAREA	SNAP	IRVSDA	IRVSPC	RATIO	IRVSN	ISAME	LOCAL
1	1	450.00	0.0	450.00	0.0	0.0	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	22.00	64.00	79.00	89.00	91.00	0.0	0.0

IRSPC COMPUTED BY THE PROGRAM IS 0.858

LOSS DATA

STKR	DLKR	RTIO	ERAIN	STKRS	RTIOK	SIRL	CSTL	ALSKA	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.10	0.0	0.0

UNIT HYDROGRAPH DATA

TP	20.00	CP	0.60	NTA	0
----	-------	----	------	-----	---

REGRESSION DATA

SIRIO	450.00	ORCON	-0.25	RTIOK	3.00
-------	--------	-------	-------	-------	------

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC 3.91 AND R 3.44 INTERVALS

UNIT HYDROGRAPH 21 END-OF-PERIOD ORIGINATES. LAG 20.62 HOURS. CP 0.60 VOL 1.00

	4015.	7040.	8220.	7109.	9303.	3955.	2950.	2200.	1641.
124.	913.	681.	508.	375.	283.	211.	157.	117.	87.

END-OF-PERIOD FLOW



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TIME	RAIN	EXCS	COMP
1	0.00	0.00	400.
2	0.00	0.00	301.
3	0.00	0.00	327.
4	0.00	0.00	290.
5	0.00	0.00	399.
6	0.00	0.00	330.
7	12.65	12.65	2039.
8	1.19	0.59	3678.
9	0.00	0.00	13755.
10	0.00	0.00	12079.
11	0.00	0.00	10366.
12	0.00	0.00	77542.
13	0.00	0.00	59079.
14	0.00	0.00	43337.
15	0.00	0.00	32338.
16	0.00	0.00	27663.
17	0.00	0.00	24264.
18	0.00	0.00	22367.
19	0.00	0.00	20640.
20	0.00	0.00	17533.
21	0.00	0.00	16037.
22	0.00	0.00	14413.
23	0.00	0.00	12914.
24	0.00	0.00	11570.
25	0.00	0.00	10263.
26	0.00	0.00	9268.
27	0.00	0.00	8311.
28	0.00	0.00	7456.
29	0.00	0.00	6680.
30	0.00	0.00	5985.
SUM	15.77	15.11	855029.

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
150699.	120599.	10218.	59120.	555029.
	2.50	8.47	14.67	17.65
59381.	20324.	231969.		424497.

CFS  
INCHES  
AC-FT

STATION 1

INFLOW 1, OUTFLOW 0 AND OBSERVED FLOW \*

0.	20000.	40000.	60000.	80000.	100000.	120000.	140000.	0.	0.
----	--------	--------	--------	--------	---------	---------	---------	----	----

PRECIP L AND EXC

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NOV 68

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HYDROGRAPH ROUTING

ISAD ICOMP IECN IIAPE JPLI JPRT INAVE

2 1 0 0 0 0 0

ROUTING DATA

QLOSS CLOSS AVG IRES ISAME

0.0 0.0 0.0 1 0

MSIPS NSTOL LAG AMSKK X ISK STORA

1 0 0 0.0 0.0 -1.

STORAGE	0.	14487.	34411.	39500.	44634.	49810.	55037.	60322.	65665.	71056.
OUTFLOW	0.	4739.	16890.	20636.	26468.	33999.	42750.	52503.	63140.	74500.

TIME EOP STOR AVG IN EOP OUT

1	1233.	403.	403.
2	1223.	382.	400.
3	1196.	342.	391.
4	1158.	307.	379.
5	1143.	339.	373.
6	1326.	1869.	597.
7	7833.	13694.	2562.
8	26695.	45412.	12184.
9	55904.	87171.	44349.
10	78897.	114127.	91166.
11	85714.	112133.	105606.
12	80859.	90705.	95344.
13	71966.	67961.	76436.
14	63541.	50708.	58911.
15	56451.	37838.	45339.
16	51147.	30101.	36237.
17	47622.	23414.	30607.
18	45021.	23666.	27013.
19	42796.	21203.	24388.
20	40717.	18997.	22014.
21	38724.	17021.	20065.
22	36705.	15250.	18573.
23	34644.	13663.	17061.
24	32574.	12242.	15770.
25	30506.	10968.	14503.
26	28489.	9827.	13279.
27	26562.	8805.	12103.
28	24747.	7889.	10996.
29	23055.	7068.	9964.
30	21490.	6332.	9010.

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	SUM	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS		105606.	105606.	92151.	54805.	816.86.
INCHES			2.18	7.62	13.60	16.87
AC-FT			52393.	162872.	326281.	404976.

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NOV 64		STATION		2	
		INFLOW I, OUTFLOW O, AND OBSERVED FLOW *			
		20000.	40000.	50000.	60000.
0.	XXXXXXO.	.	.	.	.
1.	XXXXXXO.	.	.	.	.
2.	XXXXXXO.	.	.	.	.
3.	XXXXXXO.	.	.	.	.
4.	XXXXXXO.	.	.	.	.
5.	XXXXXXO.	.	.	.	.
6.	XXXXXXO.	.	.	.	.
7.	XXXXXXO.	.	.	.	.
8.	XXXXXXO.	.	.	.	.
9.	XXXXXXO.	.	.	.	.
10.	XXXXXXO.	.	.	.	.
11.	XXXXXXO.	.	.	.	.
12.	XXXXXXO.	.	.	.	.
13.	XXXXXXO.	.	.	.	.
14.	XXXXXXO.	.	.	.	.
15.	XXXXXXO.	.	.	.	.
16.	XXXXXXO.	.	.	.	.
17.	XXXXXXO.	.	.	.	.
18.	XXXXXXO.	.	.	.	.
19.	XXXXXXO.	.	.	.	.
20.	XXXXXXO.	.	.	.	.
21.	XXXXXXO.	.	.	.	.
22.	XXXXXXO.	.	.	.	.

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# RUNOFF SUMMARY, AVERAGE FLOW

HYDROGRAPH AT	PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
ROUTED TO	1 120099.	120099.	102416.	59120.	450.00
	2 105606.	105606.	92191.	54805.	450.00

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\*\*\*\*\*  
HEC-1 VERSION DATED JAN 1973  
UPDATED AUG 74  
CHANGE NO. 01  
\*\*\*\*\*

CANNONSVILLE RESERVOIR  
NEW YORK CITY WATER SUPPLY  
TEST SPF

JOB SPECIFICATION

NQ	NHR	NMIN	1DAY	1HR	1MIN	METRC	IPLT	IPRT	ASTAN
30	6	0	0	0	0	0	2	0	0

JOPER NWI 0  
3 0

\*\*\*\*\*

SUB-AREA RUNOFF COMPUTATION

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPKT	INAME
1	0	0	0	0	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	450.00	0.0	450.00	0.0	0.0	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
8.74	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.898

LOSS DATA

STKR	DLTKR	RTIOL	ERAIN	STNKS	RTIOL	STRL	CASIL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	1.50	0.10	0.0	0.0

UNIT HYDROGRAPH DATA

IP 20.60 CP 0.60 NIA 0

RECESSION DATA

STRTD 450.00 URCSN -0.25 RTIOL 3.00  
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TO 3.91 AND R 3.44 INTERVALS

UNIT HYDROGRAPH 21 END-OF-PERIOD ORIGINATES, LAG 20.62 HOURS, CP 0.60 VOL 1.00	
1124.	4015.
1224.	913.
681.	503.
379.	283.
7109.	5303.
3959.	2950.
211.	157.
1641.	2200.
117.	117.

END-OF-PERIOD FLOW

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TIME	RAIN	LXCS	COMP Q
1	0.01	0.00	403.
2	0.03	0.00	361.
3	0.23	0.00	324.
4	0.01	0.00	290.
5	0.02	0.00	260.
6	0.11	0.00	233.
7	1.02	0.00	209.
8	0.06	0.00	187.
9	0.14	0.00	167.
10	0.66	0.06	223.
11	6.05	5.46	6226.
12	0.37	0.00	22485.
13	0.01	0.00	39053.
14	0.04	0.00	45413.
15	0.39	0.00	39423.
16	0.02	0.00	25269.
17	0.0	0.0	21343.
18	0.0	0.0	16303.
19	0.0	0.0	12169.
20	0.0	0.0	10485.
21	0.0	0.0	9394.
22	0.0	0.0	8416.
23	0.0	0.0	741.
24	0.0	0.0	6756.
25	0.0	0.0	6053.
26	0.0	0.0	5423.
27	0.0	0.0	4859.
28	0.0	0.0	4234.
29	0.0	0.0	3901.
30	0.0	0.0	3495.

SUM 9.16 5.52 305616.

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
45413.	45413.	38240.	21799.	305616.
CFS	0.94	3.16	5.41	8.32
INCHES	22530.	72885.	129782.	151623.
AC-FI				





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7X

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2X1

2X1

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7X1

7X1

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FROM ONLY RESEARCHED TO DOQ



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HYDROGRAPH ROUTING

ISTAO ICOMP 1 3441. IRECON IIAPE 0 0 JELI JPRT INAME 0

ROUTING DATA  
QLOSS CLOSS AVG IRES ISAME  
0.0 0.0 0.0 1 0

NSIPS NSIDL LAG AMSKK X ISK SIOKA  
1 0 0 0.0 0.0 -1.

STORAGE 0. 14487. 3441. 39500. 44534. 49810. 55037. 60322. 65665. 71066.  
OUTFLOW 0. 4739. 16890. 20636. 26448. 33999. 42750. 52905. 63140. 74280.

TIME	EOP	STOR	AVG	IN	EOP	OUT
1	1233.	403.	403.	403.	403.	403.
2	1223.	382.	382.	400.	400.	400.
3	1196.	342.	342.	391.	391.	391.
4	1158.	307.	307.	379.	379.	379.
5	1110.	275.	275.	363.	363.	363.
6	1056.	246.	246.	346.	346.	346.
7	999.	221.	221.	327.	327.	327.
8	940.	198.	198.	307.	307.	307.
9	880.	177.	177.	288.	288.	288.
10	833.	195.	195.	274.	274.	274.
11	2260.	3374.	3374.	739.	739.	739.
12	8574.	14505.	14505.	2805.	2805.	2805.
13	20979.	30769.	30769.	8698.	8698.	8698.
14	35397.	42233.	42233.	17616.	17616.	17616.
15	45238.	42318.	42318.	27329.	27329.	27329.
16	47757.	34246.	34246.	31004.	31004.	31004.
17	45773.	25556.	25556.	26110.	26110.	26110.
18	42345.	19073.	19073.	23858.	23858.	23858.
19	38547.	14236.	14236.	19335.	19335.	19335.
20	34938.	11327.	11327.	17278.	17278.	17278.
21	31791.	9939.	9939.	15292.	15292.	15292.
22	29040.	8905.	8905.	13614.	13614.	13614.
23	26512.	7979.	7979.	12134.	12134.	12134.
24	24465.	7148.	7148.	10824.	10824.	10824.
25	22561.	6405.	6405.	9663.	9663.	9663.
26	20871.	5738.	5738.	8632.	8632.	8632.
27	19367.	5141.	5141.	7715.	7715.	7715.
28	18028.	4606.	4606.	6899.	6899.	6899.
29	16834.	4127.	4127.	6171.	6171.	6171.
30	15769.	3698.	3698.	5521.	5521.	5521.

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	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	31004.	31004.	27575.	18888.	277314.
INCHES		0.64	2.28	4.69	5.73
AC-FT		15382.	54722.	112449.	137582.

SUM 277314.

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\*OVF\*

STATION 2

INFLOW I, OUTFLOW O, AND OBSERVED FLOW \*

	5000.	10000.	15000.	20000.	25000.	30000.	35000.	40000.	45000.	C.	J.
0.	.	.	.	.	.	.	.	.	.	.	.
1.	1.	.	.	.	.	.	.	.	.	.	.
2.	1.	.	.	.	.	.	.	.	.	.	.
3.	1.	.	.	.	.	.	.	.	.	.	.
4.	1.	.	.	.	.	.	.	.	.	.	.
5.	1.	.	.	.	.	.	.	.	.	.	.
6.	10.	.	.	.	.	.	.	.	.	.	.
7.	10.	.	.	.	.	.	.	.	.	.	.
8.	10.	.	.	.	.	.	.	.	.	.	.
9.	10.	.	.	.	.	.	.	.	.	.	.
10.	10.	.	.	.	.	.	.	.	.	.	.
11.	0.	1.	.	.	.	.	.	.	.	.	.
12.	0.	.	1.	.	.	.	.	.	.	.	.
13.	0.	0.	.	.	.	.	1.	.	.	.	.
14.	0.	.	.	0.	.	.	.	1.	.	.	.
15.	0.	.	.	.	.	0.	.	.	1.	.	.
16.	0.	.	.	.	.	.	0.	1.	.	.	.
17.	0.	.	.	.	1.	0.	.	.	.	.	.
18.	0.	.	.	1.	0.	.	.	.	.	.	.
19.	0.	.	1.	.	0.	.	.	.	.	.	.
20.	0.	.	1.	0.	.	.	.	.	.	.	.
21.	0.	.	1.	.	0.	.	.	.	.	.	.
22.	0.	.	1.	0.	.	.	.	.	.	.	.

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RUNOFF SUMMARY, AVERAGE FLOW

HYDROGRAPH AT ROUTED TO	PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
1	45413.	45413.	38240.	21759.	450.00
2	31004.	31004.	27575.	18888.	450.00

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**APPENDIX C**  
**PHOTOGRAPHS**



### Photograph Index

1. Upstream slope showing rip rap, berm, and intake tower.
2. Downstream slope from left abutment.
3. Emergency spillway crest from upstream slope.
4. Emergency spillway crest and exit channel. Note two elevations on spillway crest.
5. Emergency spillway exit channel.
6. View of outlet works and immediate downstream channel.
7. Downstream channel approximately 1/2 mile downstream of dam.

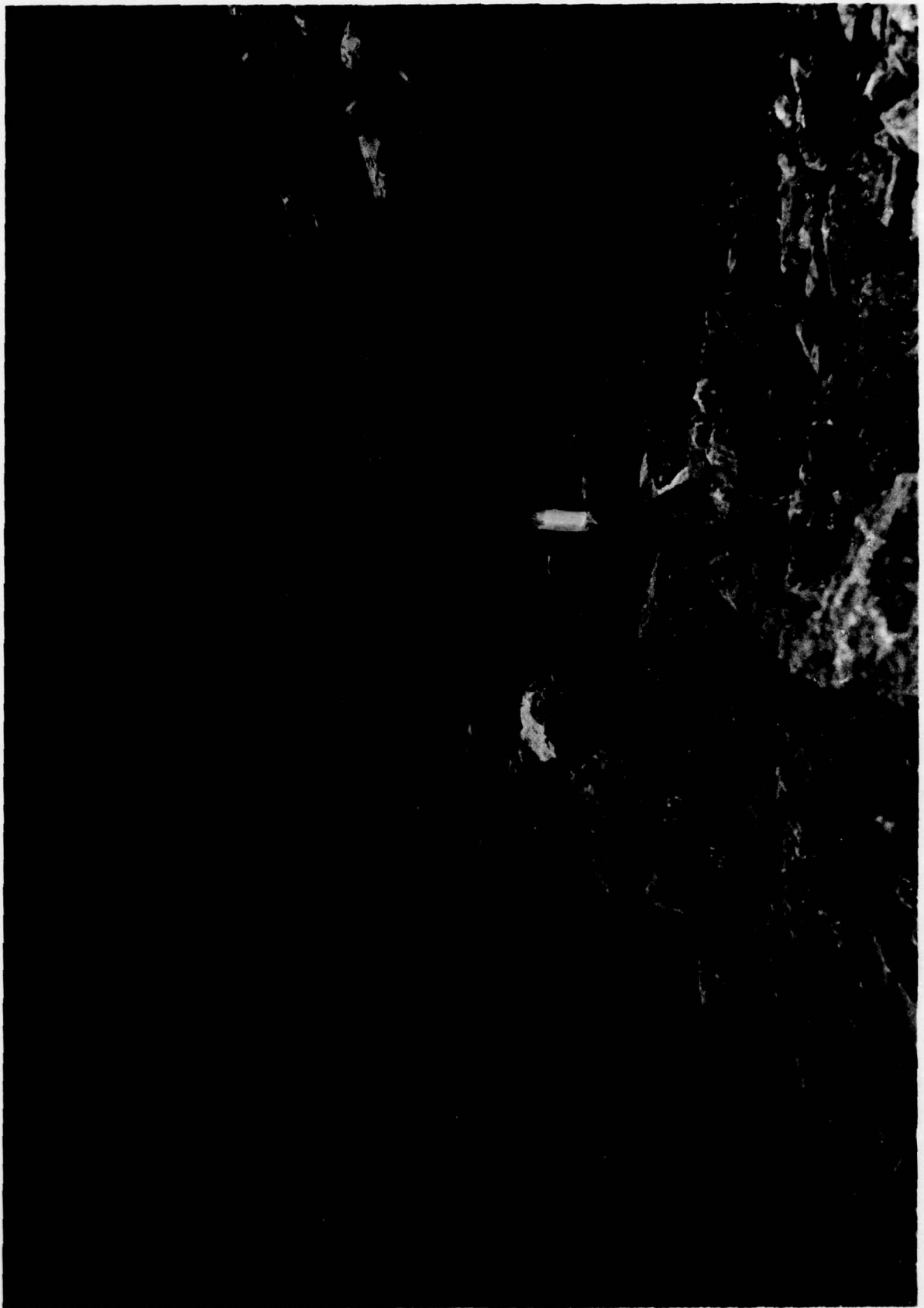


PLATE 1



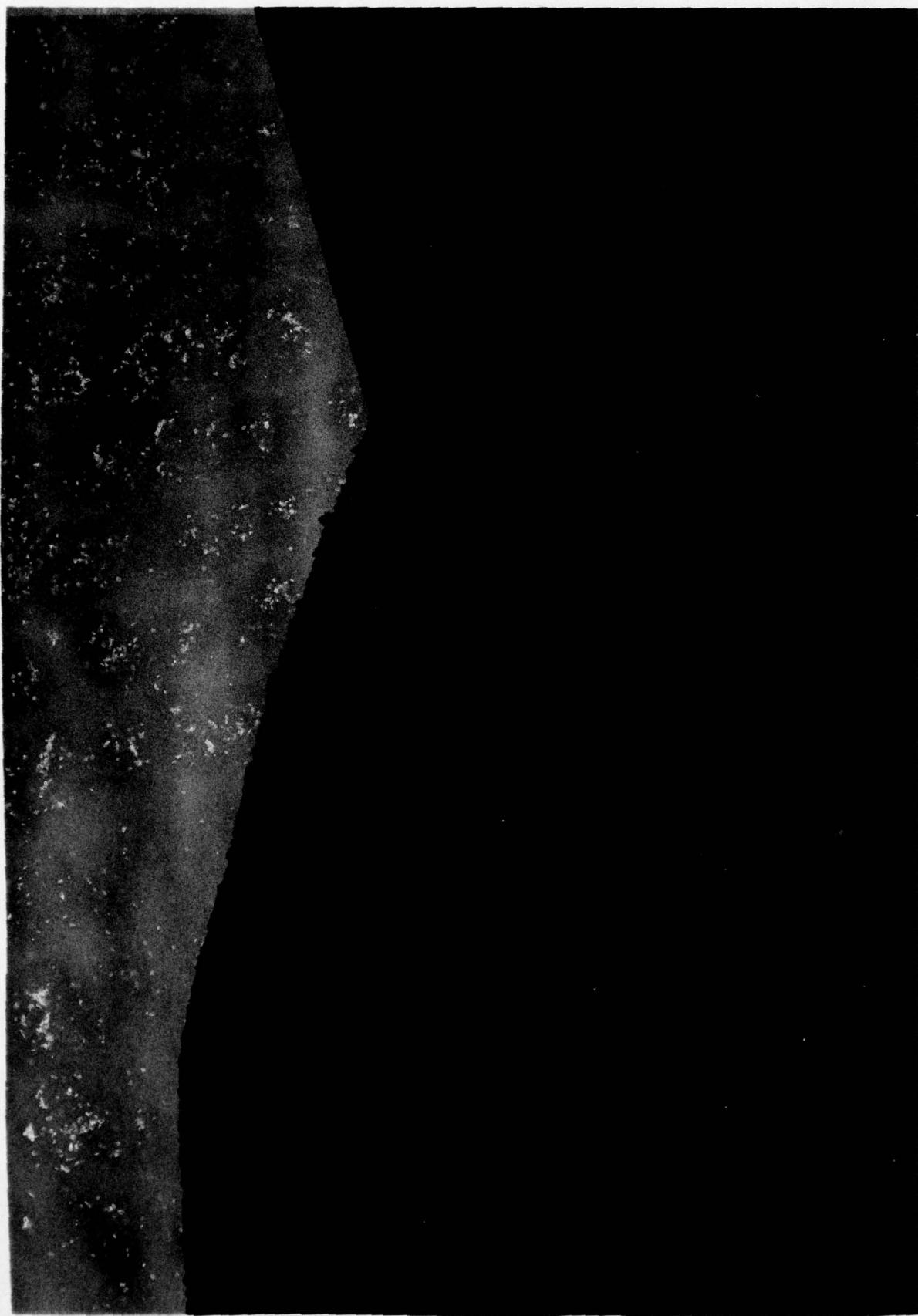


PLATE 2



PLATE 3



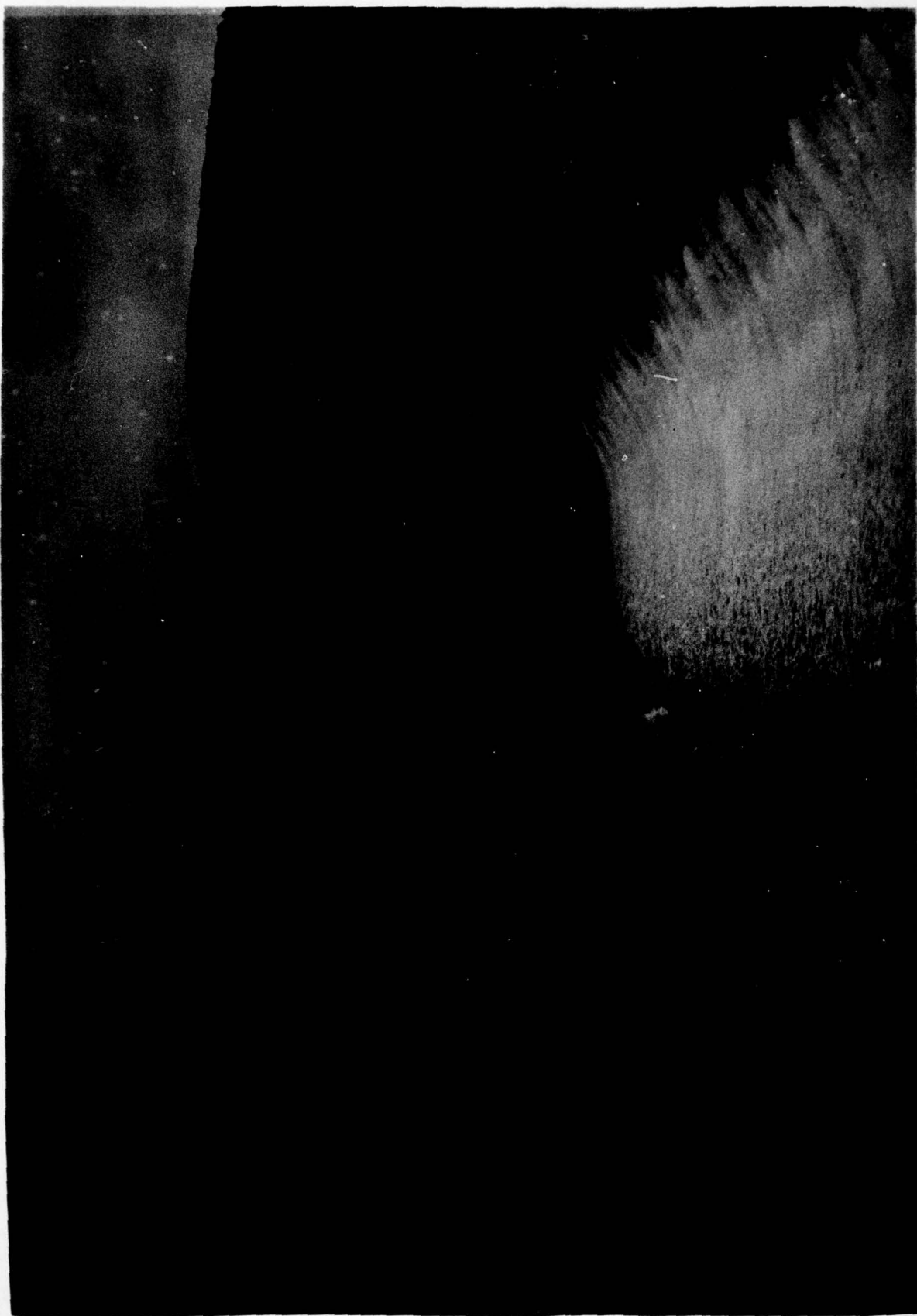


PLATE 4



PLATE 5



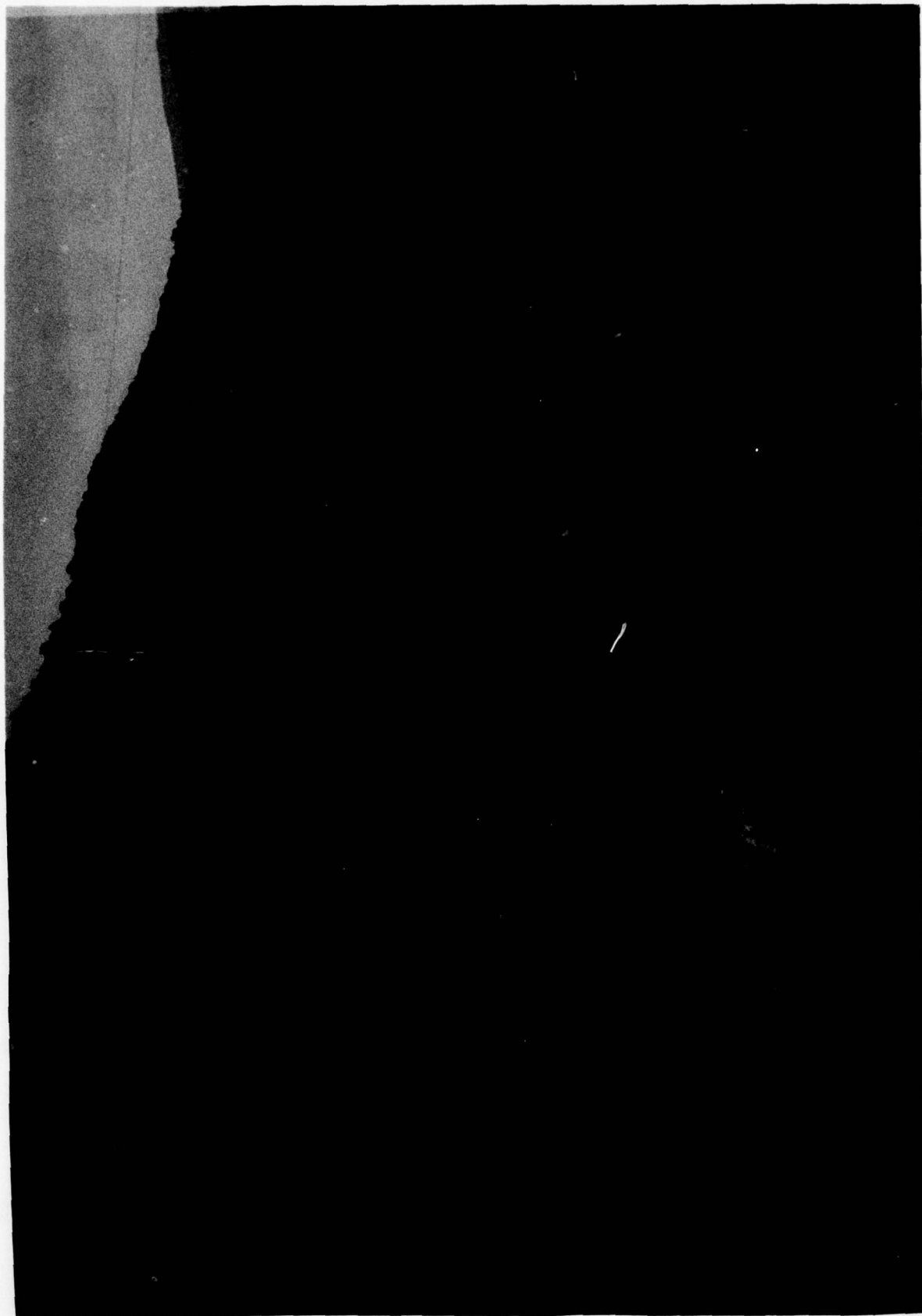


PLATE 6



PLATE 7



**APPENDIX D**

**PERTINENT CORRESPONDENCE AND REPORTS**

ST. NIKOLAI M. FRIEDMAN  
PRESIDENT

JOHN J. BURNS  
IMELON GOLAR  
COMMISSIONER

ALVIN HAUPTMAN  
CHIEF ENGINEER  
9-1-1025

# The City of New York Board of Water Supply #47-103

1250 BROADWAY  
NEW YORK, N.Y. 10001



May 26, 1978

National Dam Inspection Program  
Cannonsville, Downsville,  
Ashokan and Gilboa Dams

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Mr. Thomas D. O'Connell  
Asst. Commissioner and  
Chief Engineer  
Bureau of Water Supply, DEP  
Municipal Building  
New York, N.Y. 10007

Dear Sir:

In accordance with the request in your letter of May 2, 1978, we have been searching our files for records and information regarding the Cannonsville, Downsville, Ashokan and Gilboa Dams designed and constructed under the supervision of the Board of Water Supply. Due to the passage of time, several physical office moves, and particularly the severe space contraction imposed upon the Board recently, such records are scattered and not easily assembled.

Pertinent documents are known to exist at this office, 1250 Broadway, at the BWS office at Chelsea, N.Y. and in storage at the Bureau's Jerome Avenue pipe yard building. In addition, it may be that other data is in storage at the Pepacton Intake Chamber, and possibly other upstate installations under the Bureau's jurisdiction. Considerable data may also be in storage in The City's archives.

With respect to the five categories of information listed in your letter:

1. Engineering drawings and specifications. Contract books for Contracts 400 and 401 for Downsville Dam and Contracts 460 to 463 and 465 for Cannonsville Dam, as well as for the Catskill



May 26, 1978

Systems Dams should be in your files. If not, reproductions can be made available. A letter dated March 2, 1961 to Chief Engineer Clark indicates that tracings of contract and working drawings for the Second Stage of the Delaware System including the Downsville Dam, were delivered to your Valhalla Office. Corresponding drawings for the Cannonsville, Gilboa and Ashokan Dams are in plan files at 1250 Broadway. Prints were made after inspection by your representative, Mr. Arabito.

2. Soils information. Such information exists in the R&D files at 1250 Broadway, at the BWS Chelsea Office, and possibly in other upstate installation under Bureau jurisdiction.

3. Hydraulic and hydrologic data. Such information exists in the R&D files, in storage at the Jerome pipe yard, and possibly upstate.

4. Stability analysis. In storage at the Jerome pipe yard.

5. Historical information. Consult Board of Water Supply Annual reports for years 1946 to 1965, during which time the Downsville and Cannonsville Dams were under construction. Also there are attached herewith pertinent excerpts from the Board's Delaware Water Supply News.

Settlement plate data for the earth dams is also believed to be in storage at the Jerome pipe yard building.

Arrangements can be made for your inspection of the records under BWS jurisdiction.

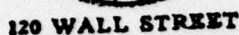
Very truly yours,

*Martin Hauptman*  
Martin Hauptman  
Chief Engineer

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Attchs.





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Vol. 23

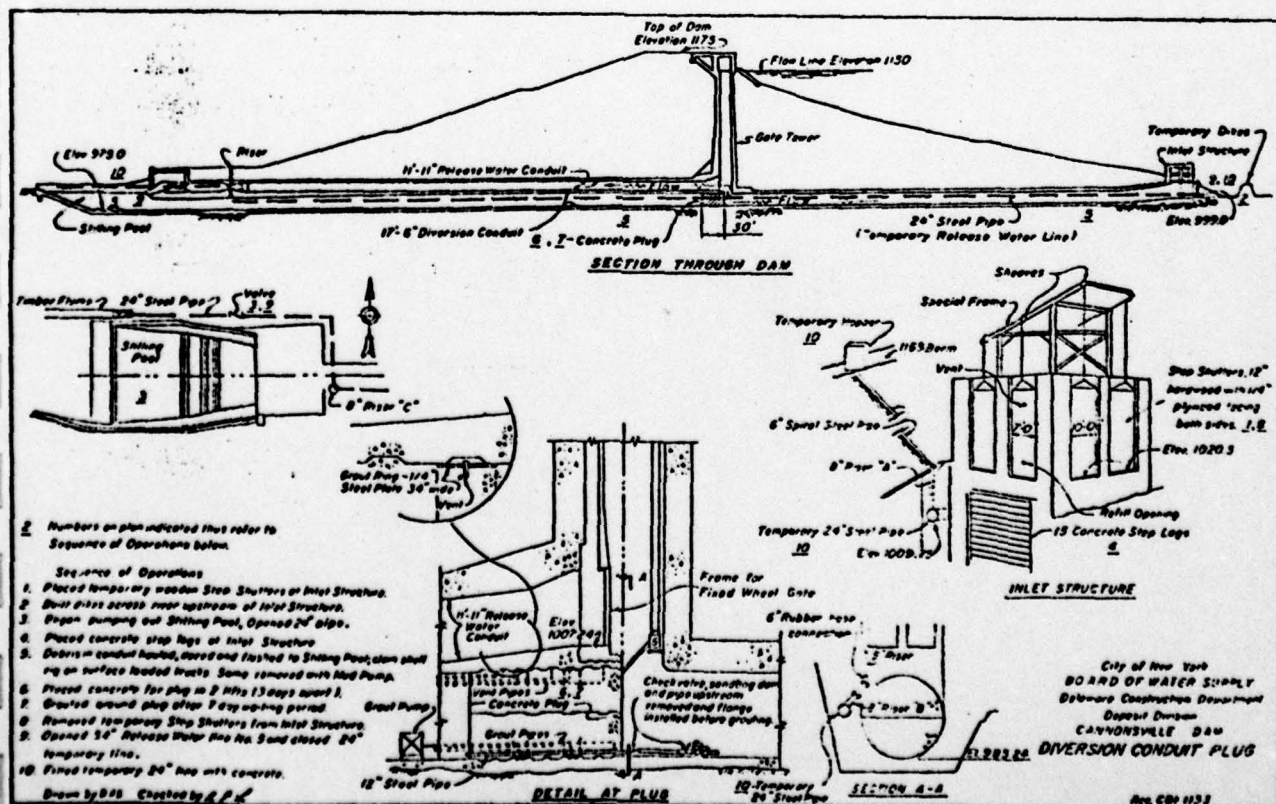
July 1, 1964

No. 190

The Cannonsville Dam, located on the West Branch of the Delaware River about four miles upstream from Deposit, New York, will impound water for about twelve miles upstream, easterly toward Walton, New York. The dam is about 2,700 feet long at the top and rises 175 feet above the valley floor to Elevation 1175. The crest of the overflow weir is at Elevation 1150, and a waste channel to the river is provided on the north side of the valley. As part of the stream control works at the dam site, a diversion conduit was constructed on the south side of the valley under the dam. The diversion conduit, through which the flow of the river was directed during construction of the dam, is 17 feet 6 inches in diameter, 1,280 feet long, and terminates in a stilling pool which discharges into the river. This conduit was designed to take advantage of pondage for the anticipated maximum flows.

At the upstream end of the diversion conduit, there is located an inlet structure in which permanent concrete stop logs and temporary wooden stop shutters were installed. A gate tower intersects the diversion conduit upstream of the centerline of the dam. Fixed wheel gates, gate frames, and guides were installed in the gate tower. These gates can be used to control water entering the release water conduit which is constructed on top of the diversion conduit from the gate tower to the Release Water Chamber. The release water conduit, a cement-mortar lined steel pipe encased in reinforced concrete, terminates in a manifold with six branches, 24 inches to 72 inches in diameter, with control valves on each line. The flow through the Release Water Works will be measured by venturi meters.

Toward the end of construction, a concrete plug was placed in the diversion conduit at the downstream side of the gate tower. After plugging, water that enters the upstream portion of the diversion conduit through the permanent openings at the inlet structure will rise in the gate tower and pass through the gate openings into the



**The Delaware Water Supply News**  
120 Wall Street, New York 5, N. Y.

An unofficial and informal publication of  
the Board of Water Supply of The City  
of New York by and for its employees.

Administrator's Office,  
Reproduction Section,  
Martin T. Geraghty, Editor.

Vol. 23      July 1, 1964      No. 190

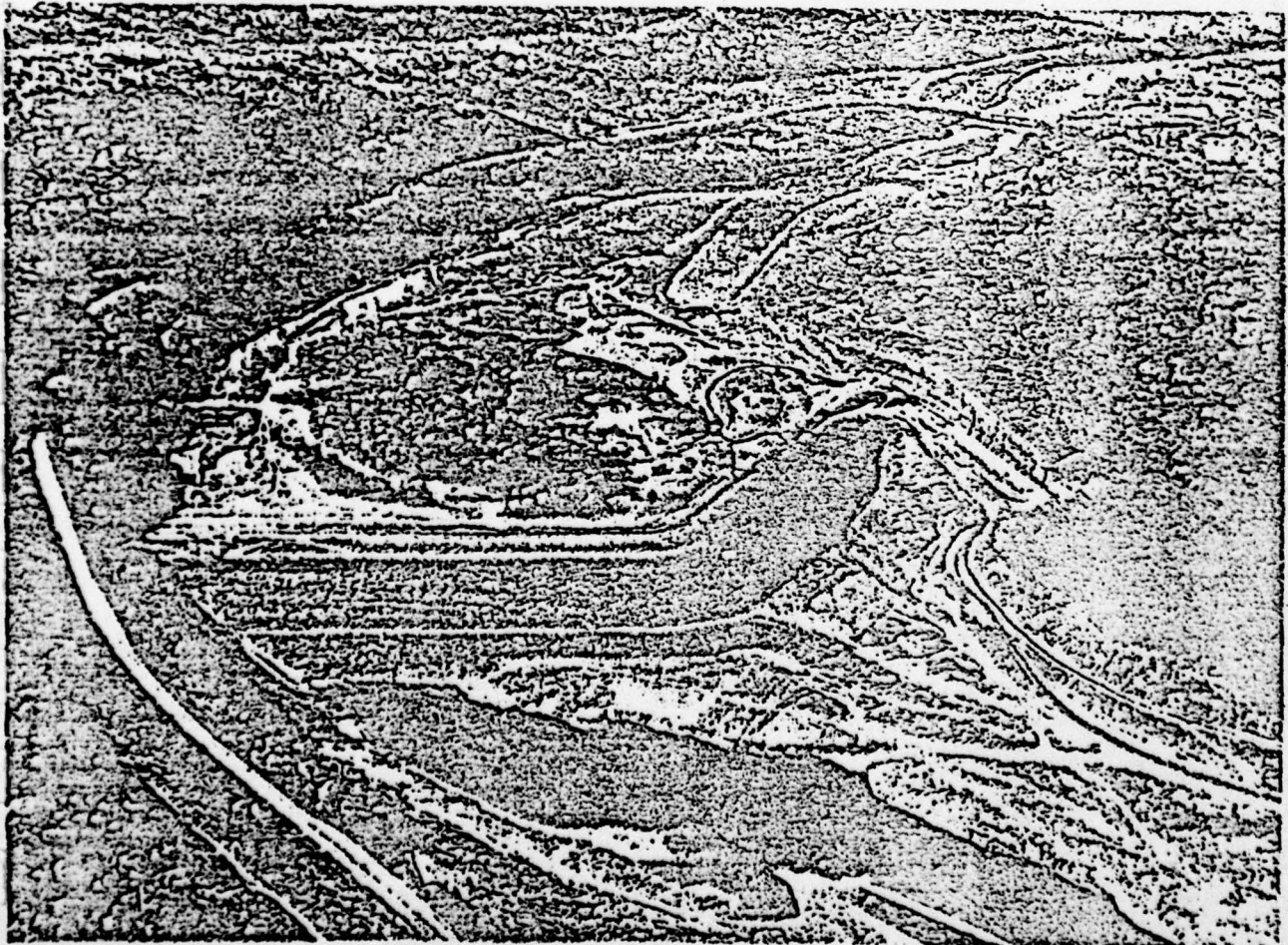
release water conduit and then through the Release Water Chamber into the stilling pool and the river. If at any time it should become necessary to shut off the flow of water in order to make repairs to the Release Water Works or for any other purpose, the fixed wheel gates will be lowered into closed position.

A temporary 24-inch release water pipe is located adjacent to the south side of the diversion conduit, beginning at the inlet structure and extending to a point upstream of the chamber. It then runs north under the

release water conduit for about 50 feet and continues westward along the north side of the stilling pool, discharging through a valve and a wooden flume into the river downstream of the stilling pool. The overall length of the 24-inch pipe is about 1,500 feet. The function of this pipe was to maintain flow through the dam site during the plugging operations.

In preparation for plugging the diversion conduit, the contractor began preliminary work at the inlet structure in September 1963. This work consisted of constructing temporary stop shutters, installing a frame on top of the inlet structure for lifting shutters, installing a flap gate and grating on the inlet of the temporary 24-inch release water pipe, setting up pumps at the stilling pool, and adding watertight sealing material to the permanent concrete stop logs.

Actual plugging operations started on September 30, 1963. Work consisted of installing the stop logs, unwatering the diversion conduit, excavating silt and debris from the conduit, stripping the existing keyway forms, forming the plug and installing grout pipes, making preparations at the tower for placing concrete in the plug, concreting and grouting the plug, and removing the stop shutters.



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Cannonsville Dam - Aerial View Looking Downstream. FROM COPY FURNISHED TO DDG



Four temporary stop shutters were fabricated in the contractor's yard, moved to the inlet, and installed prior to the installation of the stop logs. These shutters were made of 12-inch by 12-inch oak timbers, covered with 1/4-inch plywood on each face. To seal off water, permagum rubber was placed around the edges which came in contact with the concrete. The north shutter on the upstream wall had a 6-inch diameter refill opening with a flap gate at Elevation 1025.5 and a 2-inch diameter vent opening at Elevation 1035.6. These were to be used, if necessary, in refilling the conduit prior to the pulling of the stop shutters. The shutters were set in their grooves by a crane and were in place by September 28.

A special steel frame, formerly used as a portion of a bar grizzly, was adapted and mounted on top of the inlet structure for use in removing the stop shutters. Sheaves were attached to the top of the frame above each shutter. A wire rope was tied to each shutter, run through the sheave, and anchored to the dam slope above the expected high water mark.

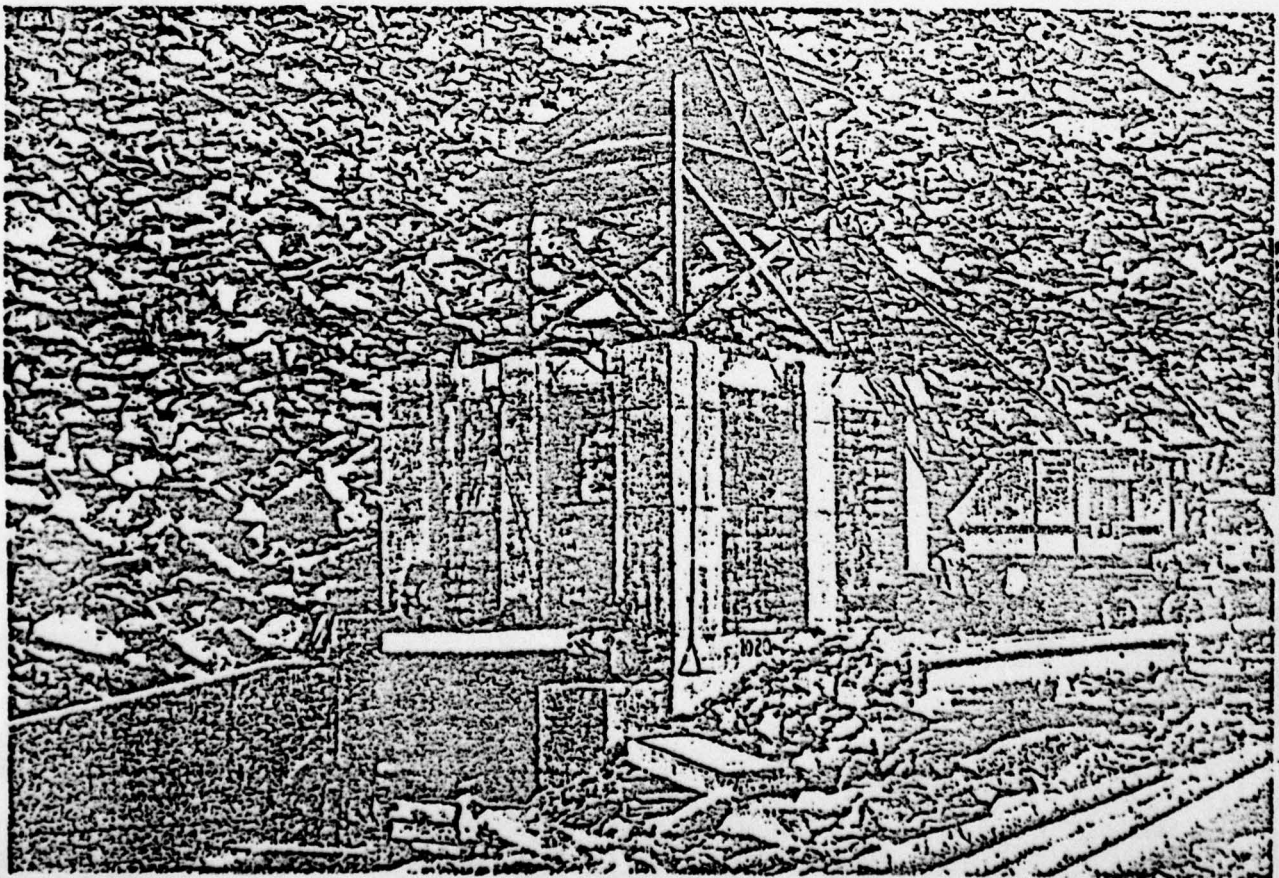
The inlet of the temporary 24-inch release water pipe was prepared for operation and closing before plugging commenced. A rack was bolted to the existing inlet frame to prevent debris from entering the pipe and a flap gate was attached with a positive closing latch which could

be secured without using a diver. By using two wire ropes and two sheaves, the flap gate could be closed and the catch pulled over the flap gate and held in position. A spiral welded steel pipe was bolted to the flange of the 8-inch riser pipe and extended up the slope of the south abutment to the berm at Elevation 1165. This pipe was used in filling the 24-inch temporary release water pipe with concrete.

At the stilling pool, a raft buoyed by oil drums was prepared with 8-inch and 10-inch electric pumps mounted thereon. This raft was placed in the stilling pool when the unwatering operation began. A 4-foot wide timber flume, 88 feet long, was constructed from the end of the temporary 24-inch release water pipe downstream to carry the flow beyond the stilling pool.

At the inlet, the fifteen permanent concrete stop logs were prepared for watertightness by affixing tarred oakum along the upstream top edges and 3-inch by 3/8-inch folded strips of permagum rubber on the downstream top edges and sides. These logs, which were pre-cast in 1962, measured 19 feet - 6 inches by 4 feet - 2 inches by 15 inches and had embedded eye bolts for lifting.

September 30 was scheduled as the starting date. When one inch of rain fell on September 28 and 29, some apprehension was felt about beginning work with the



Inlet Structure - Frame for Removing Stop Shutters. Stop Shutters in Place - Stop Logs being Installed. Acc. CDr 679

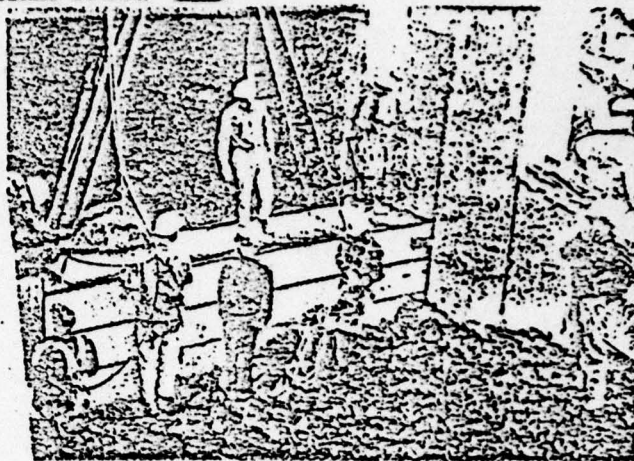
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Concrete Stop Logs Being Installed. Flap Gate of 24-inch Release Water Line at Left. Acc. CDt 671



Sealing Concrete Stop Logs. Acc. CDt. 673

possibility of flooding. However, actual work was started on the date planned. Three temporary dikes were constructed upstream of the dam to hold back the water during the installation of stop logs. As soon as the flow to the diversion conduit was intercepted by the dikes, the unwatering of the conduit began at the stilling pool. This water was pumped into a temporary settling basin just north of the stilling pool. A dike was also constructed downstream of the stilling pool to prevent the river from flowing back in. At the inlet structure, the stop logs were carefully set in position with a mobile crane and placed firmly against the concrete of the grooves. After all logs were set in position, selected fill was placed against the logs from Elevation 999 to Elevation 1009± to prevent leakage. As an added precaution, grout was placed in the log groove voids at the end of the logs, from Elevation 999 to Elevation 1017.5. Impounded water began entering the temporary 24-inch release water pipe at about 8 P.M. September 30 at Elevation 1009.75.

Unwatering of the diversion conduit was virtually completed by October 2nd. Excavation of the silt and debris followed immediately. The equipment consisted of a front end loader, a truck crane with a clam shell bucket, and back dump Euclid trucks. The crane was located adjacent to the north side of the stilling pool to remove the material from the invert of the pool. The front end loader was provided with a rounded blade for pushing the silt in the conduit to the invert of the stilling pool in position for removal by the clam shell. Water for flushing the invert clean was pumped through an opening in the temporary stop shutter. By October 12th, practically all silt and debris (about 2,100 cubic yards) had been removed from the diversion conduit and stilling pool. The silt deposits were deepest at the gate tower (6.5 feet). An 8-inch Mofetrench trash pump had to be used on the pump raft during this excavation period because of the small debris that would clog the electric pumps.

At the gate tower, a 12-inch steel pipe was installed from Elevation 1007 to Elevation 1177 for dropping concrete into a receiving boot at Elevation 1007±. From the boot, the concrete was carried by aluminum chute to the plug area, which extended 30 feet downstream from the downstream side of the tower.

On October 8 and 9, steel grout rings were installed over two of the eight existing 6-inch deep keys in the lining in the plug area. These rings consisted of 1/4-inch steel plates, 34 inches wide, placed circumferentially over the keys. A 12-inch drain pipe on the invert, including a 12-inch check valve (to carry stop shutter leakage during concreting), two grout pipes in the invert of the steel rings, and one grout pipe in the top of the 12-inch drain pipe were installed. Bulkheads were set for the lower half of the plug; and on October 10 it was concreted to the spring line with 133 cubic yards of concrete. In the arch, two vent pipes were placed in the steel rings and three vent pipes in other keys. The upper half of the plug was concreted on October 14 with 140 cubic yards. A half-yard "Air Placo" concrete placement machine, located at the downstream end of the plug, was used to complete the filling of the arch. Approximately 18 cubic yards were placed with this equipment. The air was supplied through a 4-inch spiral welded steel pipe, located on the invert of the conduit, from a portable compressor located alongside of the stilling pool. The transit-mix concrete was lowered into a front end loader at the stilling pool, carried through the conduit, dumped into the "Air Placo" machine hopper and deposited in the form.

After allowing seven days for setting of the concrete, the plug was grouted. The grouting equipment was set up at the downstream end of the plug and operated by air supplied by the same equipment used for the "Air Placo" equipment. The two invert grout pipes attached to steel rings were grouted with a mix of 10 gallons of water and

one bag of cement. Grout appeared at both ends of the plug and was caulked off and vented through the arch pipes. One hundred twenty-four bags of cement were used with pressures building up to 40 pounds per square inch. The grouting of the 12-inch drain pipe took place the next day, October 22; and required 28 bags of cement using a mix of five gallons of water to one bag of cement. All grout pipes were then filled and capped.

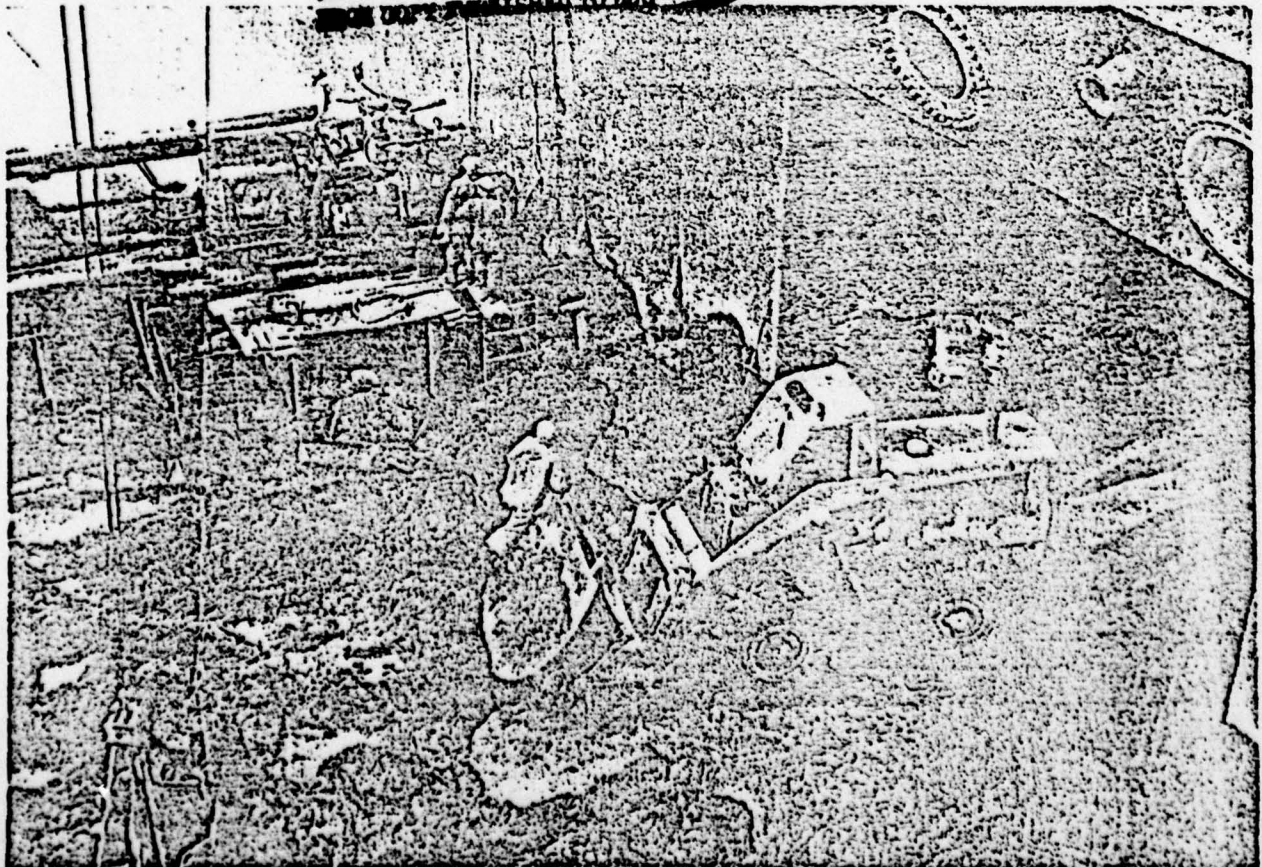
During the concreting and grouting of the plug, other work had to be completed in the diversion conduit, the release water conduit, the release water pipes, and the gate tower, i.e., cleaning of the release water conduit, the stainless steel venturi meter, and release water pipes lines Nos. 1 through 5, including the Dow pivot valves. Drains were checked, the 8-inch refill line at the gate tower, including the valve stem up to Elevation 1152, was installed, and gate guides were cleaned. Blind flanges covering the injection pipes at the gate tower and the 2-inch diameter pipes were removed, cleaned, coated with red lead and aluminum paint, and replaced. Just before the grouting operation began, the 12-inch check valve and 16 feet of 12-inch drain pipe on the upstream end of the plug were removed and a blind flange bolted to the exposed end of the 12-inch pipe embedded in concrete.

Leakage through the stop logs and stop shutters was observed during this period. There was very little leakage through the stop logs (about 2 gpm). Most of the leakage (about 30 gpm) was around the north stop shutter on the east wall of the inlet. The remaining leakage (about 13 gpm) was around the remaining three stop shutters with the water in the pond at Elevation 1023.6, approximately three feet above the sill.

During October, there was a total of 0.72 inch of rainfall; and the water level at the inlet never reached the refill pipe in the stop shutter. With the elevation at 1023.6, it was unnecessary to equalize water pressure in the diversion conduit before pulling the shutters. On October 25, all Dow pivot valves in the chamber were closed, the blind flange bolted in place in the access manhole, and then the stop shutters were pulled. At 10:30 A.M. on October 28, line No. 5 (54-inch Dow pivot valve) was opened and the 24-inch gate valve of the temporary 24-inch release water pipe closed. The flap gate at the intake of the temporary 24-inch pipe was closed on October 29 in preparation for filling the same pipe with concrete.

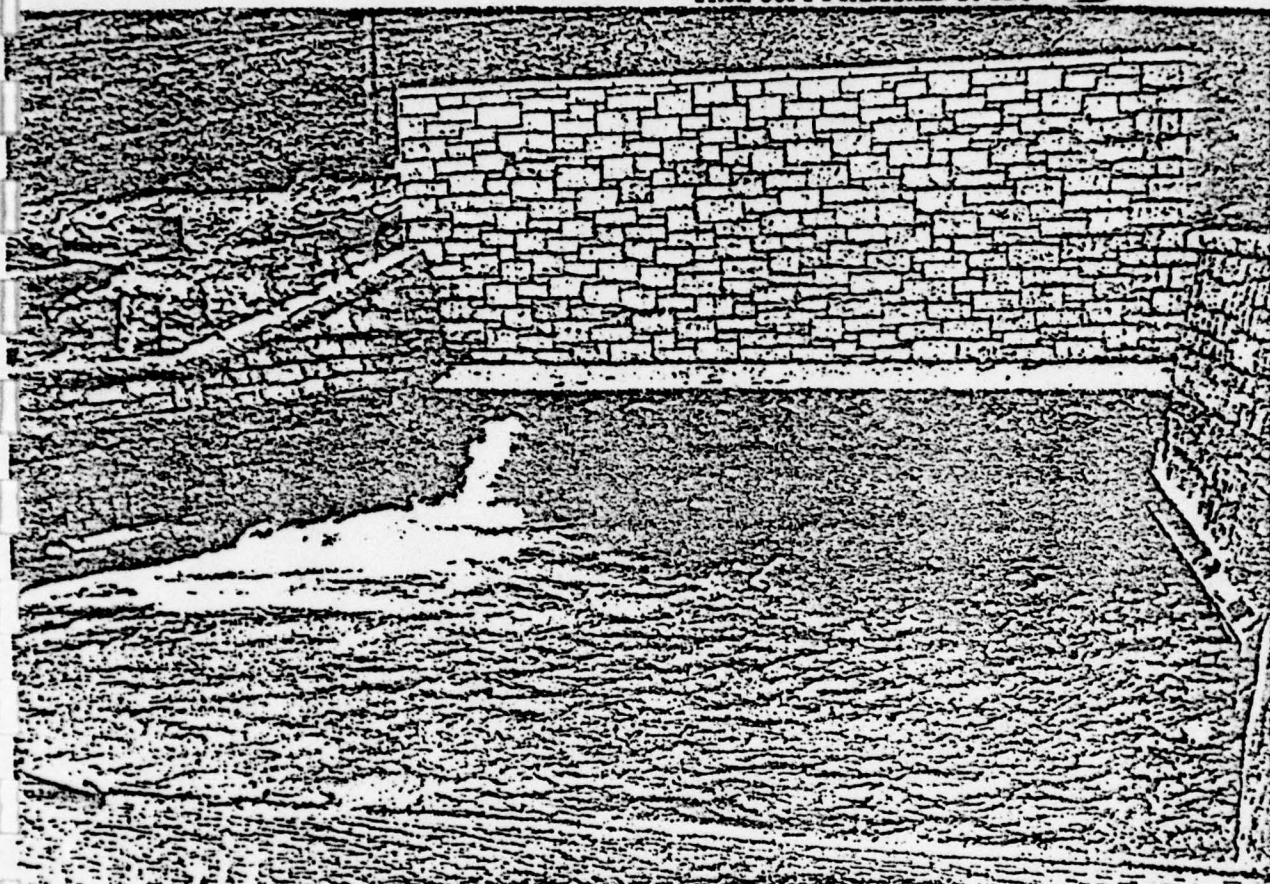
The temporary 24-inch release water pipe was unwatered and sealed at the lower end; and filling of the pipe took place on November 4. This pipe had three

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Cannonsville Dam. Stilling Pool. Water Discharging through 54-inch Release Water Line. CDr 717

8-inch risers, "A" at the inlet, "B" at the gate tower, and "C" at Station 55+62 just east of the chamber. At the downstream end of the temporary 24-inch release water pipe, there was a 24-inch gate valve and, beyond this valve, 80 feet of 24-inch steel pipe. This valve and section of pipe were removed and a blind flange with a vent installed.

Prior to concreting, samples of various concrete mixes were prepared to find a mix suitable to fill the long pipe. It was decided that a mix without coarse aggregate and with good plasticity should be used with a retarding agent to take care of unforeseen delays, none of which occurred. The mix used consisted of one bag of cement, 120 pounds of sand, five gallons of water and 25 pounds of pozzolith HP-18 manufactured by Master Builders Company. This mix was placed into the inlet of the temporary 24-inch pipe through riser pipe "A". A pipe extended from this riser pipe up the slope of the south abutment to Elevation 1168. Transit mix trucks carrying six cubic yards of concrete unloaded into a hopper at Elevation 1168. A total of 162 cubic yards of concrete was dumped into the hopper at this location and an additional 15.5 cubic yards were placed into riser "C".

When the upstream and downstream risers were removed, they were found to be filled to 26 feet and 16 feet,

respectively, above the 24-inch pipe. In the gate tower, the riser extension was connected to the embedded riser "B" by a short section of 6-inch rubber hose. It was planned to break this connection by pulling the rubber hose apart by a crane. When this was done, it was found that concrete in the riser had extended 38 feet above the 24-inch pipe. Some thought had been given to grouting the 24-inch pipe after concreting, but the above results indicated complete filling of the pipe.

SHELDON L. HADDEN

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#### CENTREX

Effective June 15, 1964 the telephone system at the Headquarters offices of the Board at 120 Wall Street, was converted to a unified telephone system called CENTREX. Outside callers can dial the offices directly by dialing 566 plus the NEW extension number assigned to each person. Please notify all callers of your new number.

## STATE OF NEW YORK



DEPARTMENT OF PUBLIC WORKS  
DIVISION OF CONSTRUCTION  
BUREAU OF WATERWAYS  
ALBANY

Received May 26, 1960Dam No. 119-2889Disposition Approved June 24, 1960Watershed Delaware River

Foundation inspected .....

Structure inspected .....

## Application for the Construction or Reconstruction of a Dam

Application is hereby made to the Superintendent of Public Works, Albany, N. Y., in compliance with the provisions of Section 948 of the Conservation Law (Chapter 602, Laws of 1959) for the approval of specifications and detailed drawings, marked Cannonsville Dam and Appurtenant Works

herewith submitted for the { construction } of a dam herein described. All provisions of law will be complied with in the erection of the proposed dam. It is intended to complete the work covered by the application about 1965

(Date)

The West Branch of

1. The dam will be on the Delaware River flowing into ..... in the town of Deposit County of Delaware and about four miles upstream from the Village of Deposit, N. Y.

(Give exact distance and direction from a well-known bridge, dam, village, main cross-roads or mouth of a stream)

2. Location of dam is shown on the attached contract drawings, Sheets 1 and 2 quadrangle of the United States Geological Survey at latitude ..... longitude .....

3. The name of the owner is City of New York, Board of Water Supply  
4. The address of the owner is 120 Wall Street, New York 5, N. Y.  
5. The impounded water will be used for Water Supply - City of New York  
6. Will any part of the dam be built upon or its pond flood any State lands? No

7. Does Section 179 of the Conservation Law (see page five of this form) apply to the above named stream? Yes.....; No..... If answer is yes, give Conservation Department's assigned number for permit to change or modify the stream See Water Supply Application 2005



9. The computed ..... year-peak rate of runoff used in the design is 200,000 cu. ft. per sec.  
State criterion of method used in determining the peak rate of runoff Myer's formula.....

10. The maximum height of the proposed dam above the bed of the stream will be 175 feet ..... inches.

11. The designed maximum high water elevation above the spillcrest is computed to be 1171.5 feet  
..... inches; the designed freeboard as measured from the maximum high water elevation to the top  
of the proposed dam will be 3.5 feet ..... inches.

12. The open spillway of the proposed dam that will control the designed flood flow will be of .....  
concrete and masonry ..... The width of the control section of  
(State type, such as: vegetated earth, concrete, masonry, timber, rock filled crib, etc.)  
the spillway, measured normal to the flow of water at the crest, will be 800 feet ..... inches in  
the clear; facing down stream, the waters will be held at the right end by a masonry wall.....  
the top of which will be 22 feet ..... inches above the spillcrest, and have a top width  
of 20 feet ..... inches; and at the left end by a masonry wall..... the top of which  
will be 25 feet ..... inches above the spillcrest and have a top width of 100+ feet ..... inches.  
The slope of the sides of the spillway will be ..... vertical ..... (left) ..... vertical ..... (right).

13. The spillway is designed to safely discharge 200,000 ..... cu. ft. per sec.

14. The surface area of the proposed pond or lake will be ..... ~~acres at the normal water~~  
~~elevation and~~ 4800 ..... acres at the spillcrest elevation; the volume of the water impounded in the  
pond or lake will be ..... ~~gallons at the normal water elevation and~~ 98 billion ..... gallons  
at the spillcrest elevation.

15a. The normal water elevation of the proposed pond or lake will be vary ..... feet ..... inches  
controlled ..... diversions through the West  
~~below the spillway crest, and will be maintained by means of a~~ Delaware Tunnel.....  
~~and releases through the release water works at the dam site.~~  
~~the pond or lake will be drained by means of a~~ .....  
~~provision will be made for supplying water to riparian owners downstream, during dry seasons, by means~~  
~~of~~ .....

15b. In addition to normal water control, provision must be made for a bottom draw-off if the pond is on  
a trout stream of constant flow. The draw-off will be by means of a release water  
5 to 15 M.G.D. ..... chamber....., designed to  
maintain an outflow of ~~one-half of the minimum inflow of the stream of~~ ..... cu. ft. per sec. up to a  
~~maximum outflow of one cu. ft. per sec.~~

16. The maximum discharge through the spillway ~~that controls the normal water elevation~~ will be  
185,000 ..... cu. ft. per sec. during maximum high water.

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designed to fail or otherwise permit full discharge through the spillway when the flood waters reach a height of --- feet --- inches above the spillcrest.

18. If an overfall structure is used as a spillway, it shall be provided with an apron constructed of ledge rock; the thickness of the --- will be --- feet --- inches, the width --- feet --- inches across the stream and the length --- feet --- inches parallel to the stream.

19. Facing downstream, what is the nature of material composing the right bank? ledge rock

20. Facing downstream, what is the nature of the material composing the left bank? ledge rock

21. The natural material of the bed on which the proposed dam will rest is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) glacial till

22. Are there any porous seams or fissures beneath the foundation of the proposed dam? seams or fissures, if any, will be grouted

23. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc. impervious glacial till

24. Was the above soil information obtained from soil borings? Yes; test pits? Yes

25. State how much above the spillcrest elevation is the lowest part of the immediate upstream adjoining property or properties, 175 feet --- inches.

26. Does this proposed pond or lake constitute any part of a public water supply? Yes

27. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the proposed dam Extremely conservative design and construction eliminates such possibility.

28. The design, plans and specifications have been prepared under the supervision of: (Sign on applicable line below).

(a) Stanley M. Dore P. E. License No. 27325  
(Signature) Stanley M. Dore  
Address 120 Wall St., New York 5, N. Y.

(b) --- U. S. D. A. Soil Conservation Service  
(Signature) (Title: Engineer or Conservationist)

(c) --- N. Y. S. Conservation Department Engineer  
(Signature) (Title)

(d) --- Other qualified engineer.  
(Signature) (Title)

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29. The erection will be under the supervision of: (Sign on applicable line below).  
(State which: Erection, Reconstruction or Repairs)

- (a) Stanley M. Dore P. E. License No. 27325  
(Signature) Stanley M. Dore  
Address 120 Wall St., New York 5, N. Y.
- (b) \_\_\_\_\_ U. S. D. A. Soil Conservation Service  
(Signature) (Title: Engineer or Conservationist)
- (c) \_\_\_\_\_ N. Y. S. Conservation Department Engineer  
(Signature) (Title)
- (d) \_\_\_\_\_ Other qualified engineer.  
(Signature) (Title)

The foregoing information is correct to the best of my knowledge and belief, and the construction will be carried out in accordance with the approved plans and specifications.

City of New York - Board of Water Supply Owner

By Betty Cohen Acting Secretary, authorized agent of owner.  
Betty Cohen

Address of signer 120 Wall St., New York 5, N. Y. Date June 22, 1960

### INSTRUCTIONS

Read carefully, on the fifth and sixth pages of this application, the law setting forth the requirements to be complied with in order to construct or reconstruct a dam.

Determine first whether the stream, across which the dam is to be erected or from which water for the proposed pond or lake is to be diverted, is under the jurisdiction of the Conservation Department. This information may be obtained upon request from the manager of the District Fisheries Office of the Conservation Department which has jurisdiction in the County where the stream is located, the Conservation Department, Bureau of Fish, State Campus Site, Albany 1, New York or the New York State Department of Public Works, Bureau of Waterways, Albany 1, New York.

Before a dam may be erected across a natural water-course, the riparian rights of other land owners (both upstream and downstream) must be considered and customarily their consent be obtained as such rights have been adjudged by the civil courts to be inalienable and inviolate.

The elevation of the impounded water should be maintained at a suitable level below the lowest contour of the adjoining properties thereby preventing inundation of the properties during the highest stage of the waters.

Each application for the construction or reconstruction of a dam must be made on this standard form, copies of which will be furnished upon request to the New York State Department of Public Works, Bureau of Waterways, Albany 1, New York. The application, properly executed, must be accompanied by three sets of plans and specifications. The plans must contain the following information:

- A topographical plan (with contours) of the impounded area drawn to a suitable scale.
- A profile and transverse section of the impounded area showing the proposed excavation, the normal water and possible high water elevations. A 1'-0" minimum of freeboard is to be provided between the top of the dam and the possible high water.
- A longitudinal elevation and transverse section of the dam with all the necessary details of the related appurtenances, spillways, drains, etc.
- A log of the soil information. Samples of the materials to be used in the dam and of the material upon which the dam is to be founded may be asked for, but need not be furnished unless requested.

No work of construction, reconstruction or repairs of the structure or structures shall be started until after the plans and specifications have been formally approved by the New York State Department of Public Works.

If the dam constitutes a part of a public water supply, application should also be made to the Water Resources Commission under Article V of the Conservation Law, as amended.

An application for the construction or reconstruction of a dam must be signed by the prospective owner of the dam or his duly authorized agent. The address of the signer and the date must be given as provided for in this application form.

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**PART THREE, ARTICLE FOUR OF THE CONSERVATION LAW  
AS AMENDED BY CHAPTER 602, LAWS OF 1959**

§ 179. Protection against damage and disturbance of streams; permit (1) No dam or other structures may be placed in any stream; except as authorized by Section 948. (2) Except as provided in this subdivision, no person shall change, alter or modify the course of any stream as defined in this section, or remove any sand or gravel from the bed of such stream or the banks thereof. (a) A person desiring to change, modify or disturb the course of any stream or to remove sand and gravel therefrom shall, before changing, modifying or disturbing the channel or bed of said stream, or before removing such sand and gravel, apply to and receive from the Conservation Department, a permit for the change or modification of the stream or for the removal of such sand and gravel. (b) The Conservation Department before granting such permit shall ascertain the extent of the damage and stream disturbance and its probable effect to create conditions dangerous to the health and safety of the people of the state, or likely to cause waste of natural resources of the state, including soil, forests, water, fish and aquatic wildlife therein likely to result from such change and modification of the water course or the removal of such sand and gravel. (c) In order to minimize the disturbance to the water course and in order to prevent unreasonable erosion of soil, increased turbidity of the waters, irregular variations in velocity, temperature and level of waters, the loss of fish and aquatic wildlife and the destruction of natural environment habitat thereof, and the danger of floods or pollution, the Department may direct the manner and the extent to which the stream bed or channel may be changed, altered or modified and may limit the quantity of sand and gravel to be removed, designate the location in the bed or channel of the stream or the banks thereof from which the same may be removed, or it may refuse permission to alter such stream or to remove sand and gravel therefrom, if in the opinion of the Department such alteration of the stream in any manner or such removal in any quantity would result in such damage to the stream as to endanger the health and safety of the people of the state of New York or the loss or destruction of the natural resources of the state including forests, soil, water, fish and wildlife. (3) The provisions of subdivision (1) and (2) shall not apply to: (a) The construction of highways, bridges, dams, reservoirs or other public works or stream improvement, soil conservation or flood control projects, undertaken by the State of New York, the federal government or the government of any county of the state; or (b) the construction of such public works by any public corporation other than the county, provided the approval of the plans therefore is first obtained from the County Superintendent of Highways of the county in which such public corporation is located; or (c) The construction of dams, ponds or reservoirs or the carrying out of measures for stream improvement, soil conservation or flood control, undertaken and carried out according to plans approved by an engineer employed by a governmental agency cooperating with a soil conservation district and supervised by a conservationist employed by such agency. (4) The Conservation Department is hereby authorized to provide expert advice and to cooperate with any person or agency desiring to undertake stream alterations to the end that the work shall progress with the minimum disturbance to the stream. (5) For the purposes of this section, except subdivision (1) thereof, a stream means a stream or a part of a stream named or described in a list prepared and published by order of the Conservation Department. In the preparation and periodic revision of such lists the Department shall determine and consider the relation between the volume and velocity of the water in a particular stream and the size, gradient and other physical characteristics of the channel in which it flows to the dangers of flooding, pollution, soil erosion or wastage of natural resources including habitat of fish and aquatic wildlife that would be involved in interference with the channel and the bed of the stream. The application of this section shall not be deemed to be postponed until the completion of a list covering the entire state.

**SECTION 948 OF THE CONSERVATION LAW  
AS AMENDED BY CHAPTER 602, LAWS OF 1959**

§ 948. Structures for impounding waters; dams and docks; control of: (1) No structure for impounding water, including any artificial obstructions; temporary or permanent, in or across a natural stream or water course, nor any dock, pier, wharf or other structure, temporary or permanent, used as a landing place on waters shall be erected, reconstructed or repaired by any person or public corporation without notice to the Superintendent of Public Works. (2) No such structure shall be erected, reconstructed, repaired or maintained without complying with such conditions as the Superintendent of Public Works may by order prescribe for safeguarding life or property including the natural resources of the state against danger or destruction resulting during the work or thereafter from the inadequate design or construction of the structure or structures or from the perilous condition of existing structure or structures or from the time at which or manner in which the work is done. (3) (a) The Superintendent of Public Works, whenever in his judgment public safety requires, shall cause investigations and reports, to be made of the structures located in the waters of the state. The Superintendent of Public Works shall have power to make and serve an order, setting forth therein his findings of fact and his conclusions therefrom, directing any person or public corporation, erecting, recon-



removing, repairing, maintaining or using any structure herein before described in subdivision (1), to either remove the said structure or to erect, reconstruct or repair the same within such reasonable time and in such manner as shall be specified in said order, and it shall be the duty of every such person or public corporation to obey, observe and comply with such an order and with the conditions therein prescribed. (b) Every person or public corporation failing, omitting or neglecting to comply with such order, or who erects, reconstructs or repairs any such structure hereinbefore referred to without submitting to the Superintendent of Public Works and obtaining his approval of plans and specifications for such structures when required so to do by his order or who fails to remove, erect, reconstruct or repair the same in accordance with the plans and specifications so approved within a reasonable time as designated by the Superintendent shall forfeit to the people of the state a sum not to exceed five hundred dollars to be fixed by the court for each and every offense; every violation of any such order shall be a separate and distinct offense, and in case of a continuing violation, every day's continuance thereof shall be deemed a separate and distinct offense. (c) In addition to said forfeiture, upon the violation of any such order, the Superintendent of Public Works shall have power to enter upon the lands and waters where such structures are located for the purpose of removing, repairing or reconstructing the same and to take such other and further precautions which he may deem necessary to safeguard life or property or protect the natural resources of the state against danger occasioned by the presence of such structures. In removing, repairing or reconstructing such structures or other properties so affected, the Superintendent of Public Works shall not deviate from the method, manner and specifications contained in the original order. (d) The Superintendent of Public Works shall certify the amount of the costs and expenses incurred by him for the removal, repair or reconstruction aforesaid or in any wise connected therewith to the board of supervisors of the county or counties in which the said lands and waters are located, whereupon it shall be the duty of such board of supervisors to add the amount so certified to the assessment rolls of such locality or localities as a charge against the real property upon which the dam or other structure is located, designated or described by the Superintendent of Public Works as chargeable therewith, and to issue its warrant or warrants for the collection thereof. Thereupon it shall become the duty of such locality or localities through their proper officers to collect the amount so certified in the same manner as other taxes are collected in such locality or localities, and when collected to pay the same to the Superintendent of Public Works who shall thereupon pay the same into the state treasury. Any amount so levied shall thereupon become and be a lien upon the real property affected thereby to the same extent as any tax levy becomes and is a lien thereon. (4) An order pursuant to this section shall be reviewable in a proceeding pursuant to Article 78 of the Civil Practice Act. (5) This section shall not apply to (a) a structure used for impounding water where the area draining into the pond or other body of impounded water formed thereby does not exceed one square mile, unless (i) the impounding structure is more than ten feet in height above the natural bed of the stream at any point or (ii) unless the quantity of water which the structure impounds exceeds one million gallons; or (b) a farm pond erected upon lands devoted to farming for the purpose of soil conservation, propagation of fish, irrigation, watering of livestock, maintenance of wildlife or general farm use, which is formed by an earth embankment with an all earth vegetated spillway and other accessory structures, unless (i) the height of the earth embankment, measured from the top thereof to the lowest point of the excavation in the reservoir area, exceeds fifteen feet; or (ii) the capacity of the farm pond exceeds one million five hundred thousand gallons measured as the total volume of water which would be impounded if the surface of the water were at the bottom of the spillway at its highest point; or (iii) the area draining into the farm pond exceeds two hundred acres; or (iv) the pond comprises more than ten acres of surface water when full; or (v) the water to said farm pond is diverted into said pond by an artificial obstruction in or across a natural stream or water course. (c) a dock, pier, wharf or other structure under jurisdiction of the department of docks, if any, in a city of over one hundred and seventy-five thousand population. (6) The design, preparation of plans, estimates and specifications and the supervision of the erection, reconstruction and repairs of all structures hereinbefore referred to shall be done by a licensed professional engineer familiar with the structures hereinbefore referred to, or in the case of farm ponds by an engineer or conservationist employed by a governmental agency cooperating with a soil conservation district, or by an engineer employed by the Conservation Department.

§ 5. This act shall not impair the effect of an order heretofore made by the Superintendent of Public Works.

§ 6. This act shall take effect October first, nineteen hundred fifty-nine.

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CONTRACT 465

BOARD OF WATER SUPPLY  
OF THE  
CITY OF NEW YORK



Information for Bidders, Forms of Bid, Contract, Bond and  
Certificates, and Specifications

FOR THE CONSTRUCTION OF THE

CANNONSVILLE DAM

AND

APPURTENANT WORKS

IN THE

TOWN OF DEPOSIT, DELAWARE COUNTY,

NEW YORK

1960



having been included in the prices stipulated for the various items of the contract. The Contractor shall not be entitled to any compensation for delay in completing any portion of the work caused by such testing, except for an extension of time equivalent to the delay.

## BORINGS

### ITEM 1

SECT. 1.1 Under Item 1 the Contractor shall make borings at such points as may be directed on and in the vicinity of the work of this contract and at such locations within or near the proposed Cannonsville Reservoir as may be ordered. Such borings shall comprise the sinking of casings to a satisfactory seat in sound rock and core drilling to such depth as required to determine the depth and character of the earth cover and the character of the bed rock, the sinking of casings for observation wells, and for holes for measuring to settlement plates in the dam, and the making of core borings in masonry or rock to explore the ground in advance of the excavation, for grouting, to test the masonry, or for other purposes. He shall also, under this item, make auger or post hole borings in the key trench and elsewhere, as ordered. As a part of the work under this item, the Contractor shall recover and preserve, as ordered, the cores and such wash or dry samples of earth and other materials which do not yield cores, and shall keep an accurate record of all materials penetrated and the depths at which changes in the materials take place. The Contractor shall furnish the Engineer with copies of all such records as the work progresses. He shall assist the Engineer in getting the necessary measurements, in obtaining knowledge of the materials penetrated, and in observing the ground water elevations, and shall satisfactorily restore all areas disturbed in making the borings.

Work  
included.

SECT. 1.2 The Contractor shall make satisfactory arrangements to begin promptly, as soon as such work is ordered, all borings that may be required during the existence of this contract, and shall prosecute the work on each boring during at least eight of the 24 hours of every working day until that boring is satisfactorily completed.

Borings to  
be started  
promptly and  
prosecuted  
continuously.

SECT. 1.3 Wherever required, other operations shall be suspended or delayed, if necessary, to permit borings to be satisfactorily and quickly made. The Contractor shall not be entitled to any compensation for such

No compensa-  
tion for delays  
in other  
operations.

suspensions or delays other than that provided in the prices stipulated for the various items of this contract.

**Sinking  
casings.**

SECT. 1.4 Casings shall be sunk vertically from the surface of the ground or excavations in earth, except as otherwise ordered. Auger or post hole borings may be made without the use of casings where the character of the soil permits and where satisfactory information may be obtained without the use of such casings. Except as permitted by the Engineer, the diameter of the casings shall permit the taking of rock cores 1 5/8 inches in diameter to the depth required. Flush joint casings shall be used and reaming of holes shall be done as required to case off soft rock or loose gravel. Wash and dry samples shall be taken at the intervals, and in the manner, directed. The Contractor shall leave in place any casings which may be so ordered by the Engineer and shall cut off such casings at the elevations directed and thread and cap them as required. Casings not ordered left in place shall be removed and, when ordered, the holes shall be filled with earth of low permeability or with sand, as ordered, under this item, as the casings are pulled or with grout as provided in Section 1.7.

**Blasting.**

SECT. 1.5 Blasting with light charges of satisfactory explosives will be allowed for the removal of boulders or other obstructions which cannot be conveniently removed otherwise. Before blasting, the Contractor shall pull the casing, if necessary, to prevent injury to it.

**Core  
drilling.**

SECT. 1.6 All core drilling shall be done with a diamond drill. Such drilling shall be done in the bed rock through casings, or in rock or masonry at ordered locations. Large boulders shall also be drilled if they cannot be removed in advance of the casing by blasting or other methods. Borings cored in rock or masonry may be ordered drilled at any angle. In bed rock as large a percentage of core as possible shall be recovered. To this end, the Contractor shall use such types of core barrels as ordered or approved and shall regulate the speed of his drill and remove the cores as frequently as directed. Except as permitted, the size of core shall be not less than 1 5/8 inches.

**Size of  
core.**

**Grouting  
core  
borings.**

SECT. 1.7 All borings made under this contract that penetrate into rock in the vicinity of the dam and elsewhere as ordered shall be filled with grout to the surface of the rock or shall be satisfactorily grouted under pressure as ordered and as specified in Item 23.



SECT. 1.8 Auger or post hole borings shall be made in earth in the excavation for the key trench and elsewhere in the vicinity of the work. These borings shall be six inches or more in diameter and of such depths as ordered up to a maximum of ten feet. Under this item, the Contractor shall furnish facilities for lighting the interior of the holes so that the materials penetrated may be examined in place. Auger and post hole borings shall be refilled, and the material satisfactorily compacted. In the key trench, the holes shall be refilled with earth of low permeability. Elsewhere they shall be refilled with approved material as ordered.

Auger or  
post hole  
borings.

SECT. 1.9 Samples of all materials penetrated by the borings, including rock and masonry cores, fragments of rock, and such wash and dry samples as may be ordered of materials which will not core, shall be preserved in receptacles furnished by the Board, numbered and marked so as to be identified readily, and delivered to such place or places as may be ordered.

Preservation  
of samples.

SECT. 1.10 The quantity to be paid for under Item 1 shall be the number of linear feet of completed borings measured, except as otherwise stipulated herein for auger and post hole borings, from the surface of the ground, or from the bottom of the excavation in earth or rock from which the boring is started, to the elevation of the bottom of the casing or to the cutting edge of the core bit in the bottom of the boring in rock, or to the bottom of the lowest piece of core in the core barrel if the entire core is not recovered. Each completed auger or post hole boring shall be measured for payment as one-half of the number of linear feet of such boring between the surface from which it was started to the bottom of such boring. The price per linear foot stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. Casing ordered left in place, including required cutting, threading, and capping, will be paid for under Item 35. No additional payment will be made for retracting or redriving the casings as required to permit blasting. If a boring in rock is lost through accident or is necessarily suspended before penetrating to the ordered depth, it shall be paid for only when the usefulness of such boring is, in the opinion of the Engineer, sufficient to warrant such payment. Should any boring be abandoned without the permission of the Engineer, no payment shall be made for any work done by the Contractor on such boring. Ordered grouting will be paid for under the appropriate grouting items. No separate payment will be made for filling any borings made under this item with materials other than grout.

Measurement  
and payment.

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## REMOVAL OF BUILDINGS

## ITEM 2

Work  
included.

SECT. 2.1 Under Item 2 the Contractor shall tear down and remove, as ordered or approved, such buildings owned by The City as are designated on the drawings or ordered, and shall satisfactorily dispose of all materials and debris. Work under this item shall be undertaken at such times as directed or approved. The removal of any buildings constructed by the Contractor for his use shall not be included in the work under this item. This item shall include, but not be limited to, the removal as ordered of all or some of the buildings listed in the tabulation below and located as shown on the contract drawings.

BUILDING	NUMBER OF STORIES	TYPE OF CONSTRUCTION	APPROXIMATE AREA OF GROUND FLOOR IN SQUARE FEET	NUMBER OF BUILDING ON DRAWINGS INDICATING LOCATION
Dwelling .....	2	Frame	685	7
Pump house .....	1	Concrete with frame roof	94	8
Dwelling .....	2	Frame	749	9
Garage and shop ....	1	Frame	615	10
Garage .....	1	Frame	288	11
Dwelling .....	2	Frame	908	12
Garage and shop ....	2	Frame	538	13
Dwelling .....	2	Frame	963	14
Barn .....	3	Cinder block and frame	1,110	15
Privy .....	1	Frame	18	28
Barn .....	2	Frame	2,842	34
Dwelling .....	1½	Frame	579	36
Privy .....	1	Frame	37	37
Henhouse .....	1	Frame	101	38

The work to be done under this item shall include the furnishing of all labor, equipment, and materials and the erection and removal of all staging, platforms, and chutes necessary to properly tear down and remove the buildings, to safeguard adjacent property and roadways, and to dispose of

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the materials and debris. The removal of any masonry foundations of these buildings and any excavation and refilling at the sites of these buildings shall not be included in this item, but, if ordered, shall be done under the appropriate items of this contract. As part of the work under this item, the Contractor shall clean out and disinfect, with an approved disinfectant, cesspools, septic tanks, privies, and the areas beneath barns, henhouses, and other buildings removed under this item, where ordered.

SECT. 2.2 The materials from the buildings removed under this item shall become the property of the Contractor, with the exception of such fixtures or materials as the Board may retain at its option. Such fixtures and materials shall be removed by the Contractor and delivered to the points directed.

Materials to  
be property  
of Contractor.

SECT. 2.3 The quantity to be paid for under Item 2 shall be the number of square feet of ground area covered by the buildings ordered removed, measured to the outside of the foundations, but omitting projections such as bay windows, chimneys, ramps, and steps and their landings. Porches and one-story sheds, having at least one side open, shall be estimated for payment as one-half the actual square feet of ground area measured as herein described. The price per square foot stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. The ordered removal of any masonry foundations of these buildings and any ordered excavation or refilling at the sites of these buildings will be paid for under the appropriate items of the contract.

Measurement  
and payment.

## EARTH EXCAVATION

### ITEM 3

SECT. 3.1 Under Item 3 the Contractor shall excavate to the lines ordered or approved, all earth and other materials which may not be properly classified under Item 4, for the dam, including the key trench and the preparation of the dam foundation; the waste weir, and its approach channel; the weir, waste, and outlet channels; the gaging weir; plants for the treatment of sewage; plants for the treatment of pumpage and drainage except at borrow pits for materials other than those required for Items 5 and 6; the ordered repair or reconstruction of the existing access roads;

Work  
included.

the construction of additional permanent access roads; the reconstruction of a portion of the town road; the removal of existing cofferdams; the control of springs in the dam foundation; sewers; drains; culverts; catch basins; retaining walls; fences and guard rails as specified in Section 15; test pits in the key trench and elsewhere; settlement measurement plates; grading in the vicinity of the dam; and for other contract purposes, as ordered. The ordered removal of walls, foundations, and other masonry, not requiring blasting, barring, or wedging, and the ordered removal of macadam or gravel pavements shall be included under Item 3. As a part of the work under this item, the Contractor shall deliver acceptable excavated materials from the excavations made under this item to the sites of refills and embankments or to temporary storage piles, and shall dispose of all excavated materials unsuitable for refill or embankment and all surplus materials as provided in Section 12. Under Item 3 the Contractor shall clean out and remove any material that may be deposited in and around the inlet structure, the diversion and release water conduits, and the stilling pool, whenever directed by the Engineer. The Contractor shall provide support, as required, for all excavations under this item and for pipes and other structures in or adjacent to such excavations, except as such support is included under Item 12, and shall maintain all excavations in good order. Without compensation other than that stipulated for the excavation ordered under Item 3, he shall construct drains, sumps, and other works to prevent the entrance of water into the excavations, shall do all pumping necessary to lower the ground water for excavation of the key trench, shall do all piping, pumping, ditching, and other required work necessary to remove and satisfactorily dispose of water from all excavations made under this item and Item 4, except the pumping specified under Item 46, and he shall do all other work and provide all equipment, materials, and supplies, for which payment under other items is not provided and which are necessary for the completion of the work as a whole. No excavation will be included under Item 3 for stream control, borrow pits, temporary water supplies, the Contractor's temporary buildings and plant, temporary roads, temporary drains, piping, and sumps, or any other temporary structures of the Contractor, except as provided in Sections 14 and 15.

Disposal of  
excavated  
materials.

SECT. 3.2 The Contractor may use the excavated materials, when suitable, for building embankments, for refilling excavations, and for other purposes. He may deposit excavated materials directly in permanent positions in refills and embankments, so far as is consistent with the proper prosecution of the work. Materials which cannot be placed at once in permanent positions may be deposited in storage piles at designated or approved locations. Materials excavated from such storage piles shall not again be paid for as excavation.



SECT. 3.3 Excavations shall be made to ordered or approved slopes or may be sheeted and braced, as approved. If permitted, the sheeting shall be placed to meet the dimensions of the structure to be built and the masonry placed against it. Unless permitted or ordered to be left in place, sheeting and bracing shall be removed. Sheeting and bracing ordered left in place will be paid for under Item 12. The furnishing, placing, and removing of any other sheeting and bracing shall be considered as a part of the work to be done under Items 3 or 47, as appropriate. The Contractor shall submit for approval detailed designs of the types of construction he proposes to use for the support of earth excavations. Where necessary, the Contractor shall build suitable bridges over the excavations as required and shall erect and maintain guards as ordered. Such bridges and guards as are ordered or approved shall be included for payment, but only as specified in Sections 14, 15, and 40.

Support of  
excavations.

Bridges and  
guards.

SECT. 3.4 The bottoms of excavations shall be taken out to the grades and shapes required for the structures to be built therein, and in no case shall the earth be dug by machinery nearer than six inches to the finished subgrade; the last six inches shall be removed with pick and shovel just before the placing of the masonry or other structures. Wherever the material is, in the opinion of the Engineer, sufficiently compact to permit a trench or other excavation to be taken out with steep sides without caving, the Contractor shall, when and where directed, excavate the material accurately to the prescribed limits and build the masonry or structures at these places without delay. Wherever the material at the established subgrade is found too soft or otherwise unsatisfactory, it shall be excavated to such additional depth and within such limits as may be ordered. As ordered by the Engineer, spaces thus excavated shall be filled with concrete, or with gravel or earth carefully selected and thoroughly compacted, to be paid for under the appropriate items.

Bottoms of  
excavations.

Compact  
earth.

Soft bottom.

SECT. 3.5 Test pits, to determine the depths and character of the underlying materials, shall be dug in earth in the excavation for the key trench and elsewhere in the vicinity of the work. The locations and dimensions of the test pits shall be as ordered. The Contractor shall assist the Engineer in making the necessary measurements, in obtaining knowledge of the materials penetrated, and in observing the elevations of any ground water. The test pits shall be refilled as ordered under Item 5, 6, or 7, as appropriate, and the refill materials shall be satisfactorily compacted. The test pits shall be dug promptly when ordered by the Engineer. Wherever required, other operations shall be suspended or delayed, if necessary, to permit test pits to be satisfactorily and quickly made. The Con-

Test pits.

tractor shall not be entitled to any compensation for such suspension or delay other than that provided in the prices stipulated for the various items of this contract.

**Modification  
of excavation.**

SECT. 3.6 If, as the excavation progresses, it is found that the nature of the material at any place is such that it is desirable to modify the shape of the excavation, either by trimming back the side slopes or taking out the excavation with steeper sides or to greater depth, width, or length, the Contractor shall make all such modifications as directed, without payment therefor other than at the price stipulated for this item.

**Unauthorized  
excavations.**

SECT. 3.7 If the action of the elements, the exigencies of the work, or other causes, should result in caving or washing of the banks or slopes, the Contractor shall take out additional material as directed. No payment shall be made therefor or for refilling with concrete or other materials, except within the lines ordered or approved, the cost of such additional excavation and refilling with suitable material beyond such lines, if necessary, being considered as having been included in the price stipulated for this item.

**Measurement  
and payment.**

SECT. 3.8 The quantity to be paid for under Item 3 shall be the number of cubic yards of earth and other materials, as described in Section 3.1, measured in place as before excavation, that are excavated to the ordered or approved lines and disposed of in accordance with the above specifications. No material shall be measured twice for payment for excavation and no payment will be made for earth excavated from borrow pits or solely to provide materials to be placed under Items 5, 6, 7, 11, and 47. Except for any sheeting and bracing ordered left in place, no direct payment will be made under any item for furnishing, placing, and removing sheeting and bracing, but the cost thereof shall be considered as included in the prices stipulated for Items 3 or 47, as appropriate. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. Ordered refilling of test pits will be paid for under Items 5, 6, or 7, as appropriate. Sheeting and bracing ordered left in place will be paid for under Item 12



## ROCK EXCAVATION

## ITEM 4

SECT. 4.1 Under Item 4 the Contractor shall excavate to the limits shown on the drawings or ordered, all ledge rock and any masonry requiring drilling, barring and wedging, or blasting, and any boulder or portion of a boulder of a content of one cubic yard or greater, and shall remove and dispose of such materials as provided in Section 12, or as ordered. In general, Item 4 shall include the excavation of rock, boulders, and masonry, to the extent ordered, for the waste weir and its approach; the weir, waste, and outlet channels; portions of the key trench; retaining walls; sewers; drains; culverts; fences and guard rails as specified in Section 15; and for other contract purposes, as ordered. No excavation will be included under Item 4 for stream control, for quarries, for temporary water supplies, for the Contractor's temporary buildings or plant, for temporary roads, for temporary drains and sumps, or for other temporary structures of the Contractor, except as provided in Sections 14 and 15.

Work  
included.

SECT. 4.2 Rock shall be excavated to the neat lines shown on the drawings or ordered, within which no rock shall project. The Contractor shall take special care to excavate closely to the prescribed lines and to avoid excavating beyond such lines. To this end he shall excavate by barring, wedging, channeling, close drilling, or other approved means where blasting would result in excavation beyond the prescribed lines or or in damage to the sides or bottoms of the excavations. Should the Contractor in any way damage the surface, or excavate beyond the ordered limits, he shall, at his own expense, remove the loosened material to the extent ordered and, at locations where masonry will come in contact with the rock, replace such material with masonry to the satisfaction of the Engineer.

Excavation  
lines.

SECT. 4.3 The rock to be excavated may be broken and jointed and unusual precautions will be required in order to preserve the rock in the sides and bottoms of the excavations in the soundest and safest possible condition. Particular care shall be taken in excavating for the waste weir and for the weir and waste channels.

Unusual  
Precautions.

As shown on the drawings or ordered, the rock in and about the proposed excavations for the waste weir, the weir channel, and a portion of the waste channel shall be consolidated by grouting, as specified under Item 23, before any rock is removed.

Pregrouting.

**Blasting.**

Excavating of rock may be done by blasting or excavating machines as approved. Blasting may be used only in such manner and with explosives of such strength and in such quantities and positions as will neither crack, shatter, nor otherwise unduly damage the sides and bottoms of the excavations, and whenever, in the opinion of the Engineer, the methods of excavation may cause undue damage, they shall be discontinued and the excavation continued by barring and wedging, close line drilling, or other approved methods.

**Procedures.**

The Contractor shall submit, for the approval of the Engineer, the procedures he proposes to follow in excavating the rock under this contract. Such procedures shall include the sequence of operations, methods of removing the rock, details of blasting including the pattern of drilling, the loading and stemming of holes, and the order of firing, and any other pertinent information. Rock excavations shall be made in accordance with the approved procedures and any approved modification thereof.

**Line holes.**

For the excavations in rock for the weir and waste channels from the upstream end of the waste weir to Station 12+61 of the waste channel, line holes spaced six inches on centers shall be drilled on the sides of the excavations along the neat or payment lines or in between as approved. For the excavation of rock at other locations, the holes along the sides of the excavations shall be spaced not more than 15 inches on centers, unless otherwise approved by the Engineer. The holes along the sides of the excavations shall be drilled before any blasting, within ordered or approved distances, is done or before excavation by excavating machines approaches closer than six feet to the neat lines. The holes along the sides shall be drilled for the full depth of the excavations. These holes shall not be loaded with explosives except as loading with light charges is permitted.

**Center cuts.**

The excavations in rock for the waste weir and weir and waste channels shall be made by excavating center cuts to lines not closer than six feet to the neat lines along the sides of the excavations. However, for the rock higher than the existing rock surface at the downhill side of the excavation and outside of the six-foot line on the uphill side, the center cut may be omitted if satisfactory methods, as approved by the Engineer, are used. After such initial cuts have been made, the removal of the rock

**Sides.**

remaining at the sides of the excavations shall be by methods approved by the Engineer and conforming to the requirements of these specifications.

**Pre-splitting  
of rock.**

In lieu of the line drilling and center cuts specified above, the Contractor may pre-split the rock along the walls of the excavations before blasting between such walls, provided that the Contractor satisfies the Engineer that the proposed procedure including blasting after pre-splitting has been successfully used under similar conditions and provided that the



proposed procedure is approved by the Engineer. Spacing holes more than 24 inches apart along the walls of the excavation or using holes less than 2½ inches in diameter will not be approved for pre-splitting. If, in the opinion of the Engineer, the results being obtained at any time are not equal to those obtained by the specified method, the Contractor shall discontinue pre-splitting and proceed with the excavation in accordance with the specified method of line drilling and center cuts.

The size of cut removed by any one blast will be governed by the character of the rock formation. Unless otherwise specifically permitted, the maximum vertical depth of any cut at the top of an excavation in rock shall not exceed ten feet and its maximum volume shall not exceed 300 cubic yards. Size of cut.

SECT. 4.4 If, as the excavation progresses, it is found that the nature of the rock at any place is such that it is desirable to modify the shape of the ordered excavation, the Contractor shall make all such modifications as directed by the Engineer. Where such modifications are ordered before the rock has been line drilled in accordance with Section 4.3 along the prescribed lines as originally established, the additional rock excavated in accordance with such modifications will be measured for payment as the number of cubic yards between the originally established and the new payment lines. However, where such modifications are ordered after the rock has been line drilled in accordance with Section 4.3 along the prescribed lines as originally established, the additional rock excavated in accordance with such modifications will be measured for payment as 1½ times the number of cubic yards between the originally established and the new payment lines. Modification of excavation.

SECT. 4.5 Whenever directed during the progress of rock excavation, all dirt and rock which shall have been loosened shall be removed from designated areas, and the surfaces of the rock shall be cleaned, using steam to melt snow and ice, if necessary. The water shall subsequently be removed from the depressions so that the whole surface of the areas can be inspected to determine whether seams or other defects exist. Preparation for inspection.

SECT. 4.6 The surfaces of the rock against which masonry is to be placed shall be left sufficiently rough to provide a good bond and, if required, the foundations shall be cut to rough benches or steps. Before any concrete masonry is built on or against the rock, the rock surface shall be prepared as specified in Section 14G.20. Preparation of rock surfaces.

Clearing  
rock for  
measurement.

SECT. 4.7 For the purpose of measuring rock before excavation, its surface shall be cleared of obstructions interfering with correct measurement, and the surface so cleared shall be of reasonable extent. The Contractor shall notify the Engineer when any rock is ready for measurement and only such rock as has been properly measured will be paid for.

Measurement  
and payment.

SECT. 4.8 The quantity to be paid for under Item 4 shall be the number of cubic yards of rock, boulders or portions of boulders of a content of one cubic yard or greater in the excavations and of masonry, as described in Section 4.1, that are excavated in accordance with orders, measured in place as before excavation and within the limits prescribed below. Wherever all loose rock and rock debris are ordered removed from the bottom of an excavation in rock, to provide a foundation for masonry or otherwise, measurement shall be made to lines 12 inches below the ordered neat lines, as shown on the drawings or ordered. Where loose rock and rock debris are not ordered removed from the bottom of an excavation, measurement shall be made to the ordered neat lines of such bottom. On the sides of the excavations in rock, measurement shall be made to lines 12 inches outside of the ordered neat lines, as shown on the drawings or ordered. Excavations made outside of the ordered limits shall not be estimated for payment, and shall be refilled with suitable material, as ordered, without compensation therefor. Where the excavation has been modified as directed and such modification was ordered after the rock had been line drilled along the originally prescribed lines, the additional rock excavated in accordance with such modification shall be measured for payment as being  $1\frac{1}{2}$  times the actual quantity in place before excavation between the old and the new payment lines. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. Except for the pumping specified under Item 46, the removal of water from excavations in rock under Item 4 is included under Item 3. No direct payment will be made for excavating rock from quarries or solely to provide materials to be placed under Items 8, 9, 15, 16, and 47, nor for excavating rock for temporary roads, for the Contractor's temporary buildings and plant, for temporary water supplies, for temporary drains or sumps, or for other temporary structures of the Contractor, but the cost thereof shall be considered as included in the prices stipulated for the various items of the contract. Any ordered excavation of rock spoil, including all boulders therein of less than one cubic yard content, deposited under a previous contract will be included for payment under Item 3. No direct payment will be made for any masonry placed as specified in Section 4.2 nor for any cement used in such



masonry, but the cost thereof shall be considered as included in the price stipulated for Item 4. Ordered pregrouting will be paid for under the appropriate items.

### ROLLED IMPERVIOUS EMBANKMENT AND ROLLED SEMI-PERVIOUS EMBANKMENT

#### ITEMS 5 AND 6

SECT. 5.1 Under Items 5 and 6, the Contractor shall furnish and place and compact rolled impervious embankment and rolled semi-pervious embankment, respectively, to the lines shown on the drawings, as specified herein and as ordered by the Engineer. Item 5 shall include rolled impervious embankment for the dense impervious zone of the dam and for dense impervious blankets on earth or ledge rock. Item 6 shall include rolled semi-pervious embankment for the permanently stable semi-pervious zones of the dam and for semi-pervious blankets. Carefully selected and naturally graded materials from approved borrow pits shall be used in the embankment to be placed under Item 5. Suitable materials from excavations required for other parts of the work or from approved borrow pits shall be used in the embankment to be placed under Item 6. The materials to be used and their suitability for either type of rolled embankment, the moisture content of these materials when compacted, the maximum sizes of stones permitted in the embankment, the thicknesses of the layers of materials placed in the embankment, and the necessary rolling to attain the degree of compaction required in the various portions of the embankment shall be as hereinafter specified and as directed by the Engineer. The Contractor shall furnish all equipment, plant, and labor required to obtain and transport the materials, control their moisture content, and thoroughly compact them in the embankment and shall cooperate to the fullest extent in utilizing the available materials to the best advantage. As a part of the work under Items 5 and 6, the Contractor shall, to the extent directed, do any work at and adjacent to the diversion and release water conduits and emergency gate tower necessary to prepare the surfaces for the placing of embankment.

Work included.

SECT. 5.2 A firm base for the embankment shall be prepared as directed by filling all holes and depressions with suitable materials and compacting such materials, by placing drains for the control of ground water, by filling and sealing all existing pump and observation wells with grout or other suitable material as ordered, by removal of all sewer or other pipes, by plugging or draining any springs encountered on the site,

Preparation of base.

and by removal of unsuitable surface materials. Wherever rolled impervious embankment is to be placed directly upon bed rock, all joints in the exposed rock shall be cleaned of earth and other materials to a depth of 12 inches and shall be filled, under Item 23, by brooming or other approved method, with grout consisting of cement, sand, and water in the proportions directed. Surfaces of the base of the embankment, particularly the sloping surfaces at the abutments and elsewhere, shall be prepared to provide a satisfactory bond. The preparation and grading of the abutments of the dam and the completion of such work shall be done well in advance of placing embankment and as directed by the Engineer. This preparation shall also include the removal of any overhanging or loose rock exposed in the abutments and key trench of the dam or elsewhere which, in the opinion of the Engineer, will interfere with the proper placing and compacting of the embankment materials. If the prepared foundation should for any reason be found by the Engineer to be unsuitable for receiving embankment, it shall, immediately before placing embankment, be ploughed, harrowed or otherwise worked as directed, to a depth of from six to eight inches, with the addition of water if required, and compacted in the manner specified in Section 5.6. All ordered excavation and removal of materials necessary to prepare the foundations and all ordered masonry, pipes, grout, cement, or other materials used for the control of springs or for filling existing wells shall be included for payment under the appropriate items, but no other direct payment shall be made for the preparation of foundations as herein specified, it being considered that compensation therefor is included in the prices stipulated for the several items of excavation and embankment.

**Quality of  
materials.**

**Gradation of  
materials.**

SECT. 5.3 Rolled embankment shall consist of suitable materials from borrow pits and from excavations required for other parts of the work. Materials containing a large proportion of silt, such as the lake bed sediments, may not be used for either type of embankment except where the use of such materials in special cases and to a limited extent is specifically approved by the Engineer. The suitability of the materials to be placed in each portion of the embankment and the approximate limits of each such portion shall be determined by the Engineer. In general, materials from the borrow pits containing a sufficiently large proportion of fines to make such materials sufficiently impermeable when compacted shall be placed in the impervious zone of the dam and in the impervious blankets. Materials from required excavations, and from borrow pits if not sufficiently impermeable for the impervious zone and blankets, may be used in semi-pervious embankment as permitted. Coarse and free draining materials will be required to be placed in the upstream semi-pervious embankment between the riprap and the impervious zone of the dam, over impervious



blankets, and in the outer portion of the downstream semi-pervious embankment. In the downstream semi-pervious zone of the dam, materials of low permeability shall be placed nearest the impervious zone and coarse materials of high permeability shall be placed in the downstream section of the semi-pervious zone. The remainder or middle section of the downstream semi-pervious zone of the dam shall be made of any suitable materials which may vary from materials of low permeability to coarse permeable materials. To the end that the downstream portion of this semi-pervious zone shall be satisfactorily coarse and free draining, boulders and stones free of adhesions of lumped clay from the borrow pits and the excavations may be used in lieu of other coarse materials if and in the manner permitted. Any use of boulders and stones in the semi-pervious zone will be included in the work of Item 6 and not under Item 8. The use of materials of very low permeability will not be allowed in the construction of semi-pervious embankment except that such materials may be used to a limited extent, as approved, in that portion of the downstream semi-pervious zone adjacent to the impervious embankment placed under Item 5. Any use of materials of very low permeability permitted in the semi-pervious zone will be included in the work of Item 6 and not under Item 5. Embankment materials shall be free from stumps, roots, ashes, oil, or other perishable or foreign materials. Oversize stones shall be removed from materials for impervious embankment before they are brought onto the embankment by passing the materials through an approved grizzly. The grizzly shall be a bar grizzly having openings between the bars not more than nine inches in width unless another type of grizzly is necessary because of the character of the material in the borrow pit and is approved by the Engineer. Any remaining stones in impervious embankment materials that interfere with proper compaction and any stones in materials for semi-pervious embankment that interfere with proper compaction shall be removed at the embankment. All such stones shall be disposed of as directed and, if of acceptable size and quality and satisfactorily free from earth, may, if approved by the Engineer, be placed in the outer portion of the downstream zone of semi-pervious embankment or in the rock embankment of the dam. Materials for impervious embankment to be placed directly on ledge rock in the key trench and elsewhere and materials to be compacted by equipment other than the 50-ton roller specified in Section 5.11 shall not contain stones larger than four inches. Accumulation of stones in groups or nests, particularly stones of the larger sizes, shall not be permitted in impervious embankment nor in designated portions of semi-pervious embankment. Sufficient personnel and equipment shall at all times be available to prevent such accumulations and to remove all oversize stones, roots, and other unsuitable materials. All operations related to excavating, transporting, and placing of materials and removing oversize stones shall be such as will produce a satisfactory mixture, gradation, and moisture con-

Removal  
of stones.

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Mixing materials for impervious embankment.

tent of the materials for embankment after they have been spread and compacted. The completed impervious embankment shall be free from lenses, pockets, streaks, or layers of material markedly differing in texture from the surrounding material. Operations in the borrow pits and at the grizzlies shall be scheduled in such manner that the materials for impervious embankment will be mixed as thoroughly as possible. In the borrow pits such materials shall be excavated and loaded by power shovels which shall, as may be necessary or required, be operated as mixers with open dippers. Materials shall be excavated from approximately vertical faces of substantial height. Other excavating and loading devices may be approved, provided the mixing produced is as efficient as that of the shovels above specified. No materials shall be used for rolled embankment unless they are of the required quality, gradation, and moisture content. Unsuitable materials will be rejected and shall be disposed of as directed.

Frozen materials.

SECT. 5.4 No frozen material shall at any time be used in the construction of either type of rolled embankment and no material shall be placed on portions of such embankments which are frozen or which have been loosened by freezing. Upon resumption of work after freezing weather, the surfaces of the embankments shall be prepared as specified in Section 5.2 or as directed by the Engineer.

Borrow pits.

SECT. 5.5 The Contractor will be permitted to open borrow pits on lands owned by The City at such locations, to such extent, and in such manner as approved by the Engineer. The top surfaces of the borrow pits shall be stripped and shall be graded and smooth rolled and otherwise treated so as to shed rain water (See also Section 5.8). On or before the completion of the work, all portions of borrow pits above Elevation 1100 shall be graded and sloped as required and all unsightly piles of rock, isolated boulders, and other debris shall be removed or covered. All borrow pits shall be left in an acceptable condition at the completion of work under this contract as provided in Section 13. No direct payment will be made for these cleaning up operations, it being understood that the cost thereof is included in the price stipulated for Item 49.

Construction of embankment.

SECT. 5.6 The dumping, spreading, sprinkling or drying, and compacting of embankment may be carried on simultaneously at different places. In case these operations tend to or actually do interfere with each other, the Engineer may require them to be done consecutively whenever in his judgment such procedure is necessary to insure the required quality of



work. Materials for the construction of embankment shall be transported on the dam in approved conveying units of such ample bearing areas that the compacted fill will not be rutted by their passage. These units shall be dispatched at the excavation, borrow pit, or stock pile to the portion of the embankment for which the material is suitable and in which it is to be placed. Approved means of identifying the units shall be provided. Conveying equipment shall not be permitted to follow tracks on the dam and the routes of travel shall be varied and spread out and ruts on the embankment shall be promptly filled and leveled off. Unless otherwise permitted, embankment surfaces over which hauling has been done shall be scarified before any new layer is placed. The embankment material shall be evenly and uniformly spread in layers, as nearly as practicable 14 inches thick measured before compaction for impervious embankment and as nearly as practicable 24 inches thick measured before compaction for semi-pervious embankment. Layers of lesser thickness than above specified shall be placed where necessary to meet the ordered limits of the type of embankment being placed. The discharge gates of the conveying units shall be adjusted, as approved by the Engineer, to insure that materials will be deposited satisfactorily. Arriving material shall be dumped in evenly spaced rows adjacent to each other and, in general, parallel with the axis of the dam, so that the spreading and rolling equipment will travel parallel to that axis. The spreading equipment shall be as approved and no other equipment, except sprinkling trucks, and scarifiers as necessary, shall be permitted to pass over any layer that is being or has been prepared for rolling until after the rolling of that layer has been completed. Joints and laps in layers shall be carefully made so as to insure the continuity of each layer in all directions. Each layer shall be thoroughly compacted to the extent required before a new layer is placed. Such compaction shall be accomplished by rolling with a 50-ton rubber-tired roller of approved design or, in special cases, by other approved means as specified in Section 5.12. The number of roller passes shall be as ordered by the Engineer (See Sections 5.10 and 5.14). The roller shall be drawn by an approved tractor having ample bearing area. Their rate of travel shall not exceed ten miles per hour. All methods and procedures of spreading materials, moisture control, and compaction will be carefully supervised and controlled to the end of securing optimum results of density and stability within the requirements of these specifications. Samples for density determinations shall be taken by the Contractor for and under the supervision of the Engineer from the layer just below the compacted top layer at the point of sampling. The Contractor shall provide personnel, as required by the Engineer, for this work. The frequency and locations of sampling shall be as directed by the Engineer. No direct payment shall be made for any work required in connection with obtaining samples or satisfactorily refilling the holes.

Thickness  
of layers.

Compaction  
of layers.

Density  
samples.

**Moisture  
content.**

SECT. 5.7 The moisture content of the material placed in the embankment shall be as prescribed by the Engineer. For the impervious embankment, the percentage, by weight, of water in the material shall be such as will permit compaction of the material in the embankment to not less than 97 percent of the maximum density obtainable with the specified rolling equipment; for semi-pervious embankment the moisture content shall be such as will permit compaction to the density necessary, in the opinion of the Engineer, to insure a condition of permanent stability. Dry weight of a unit volume of the compacted material will be used in determining the density. Changes in the prescribed moisture content may be made from time to time to conform to changes in the character and grading of the material.

**Control of  
moisture  
content at  
the borrow  
pits.**

SECT. 5.8 A considerable measure of control of the moisture, particularly for the impervious embankment material, will be effected in the borrow pits. The procedures for obtaining such control will necessarily be continuous and must be planned sufficiently in advance of excavating the material to minimize delay in the progress of the work. Removal of water from rainfalls, springs, or other sources may necessitate the construction of intercepting and diversion ditches and the constant exposure to sun and air of the greatest possible area in the borrow pit. In the event that materials being excavated are unsuitable because of excessive moisture content, the Contractor will be required to move to other locations in the borrow pit where the moisture content of the materials is suitable.

**Control of  
moisture con-  
tent at the  
embankment.**

SECT. 5.9 The top surface of the embankment shall be sprinkled whenever necessary just before a new layer is placed and to prevent dust from reducing visibility. Whenever the moisture content of the material arriving at the embankment is too low, such material shall be sprinkled and scarified as ordered after it has been spread and before it is compacted. All such sprinkling shall be done by tank trucks of approved weight and design. The delivery nozzles of the trucks shall be capable of close and accurate adjustment so that the water will be uniformly spread and closely controlled as to quantity without forming pools. Material which is found to be too wet when it reaches the embankment or becomes too wet shall, before it is compacted and as approved by the Engineer, be spread over the embankment, scarified, or otherwise exposed to the drying action of the sun and air and the excess moisture allowed to dry out before it is compacted or it shall be removed. The placing or rolling of material on impervious embankment will not be permitted whenever rainstorms are imminent or during or immediately after rainfalls or when any other weather condition prevails which would increase the moisture content beyond the



limit for satisfactory compaction. The top of the entire embankment shall be graded and sloped transversely so that a minimum of rain water will be retained thereon. The slope of the top of the impervious embankment shall be at least three percent. The top of the semi-pervious embankment, except as may be permitted adjacent to the outside of the embankment, shall be kept at all times during its construction slightly below the top of the impervious embankment in order to afford satisfactory drainage of surface water. The top of the embankment of either type shall be kept free from holes and depressions and all such as may be formed by any cause shall be promptly leveled off as directed by the Engineer. Pools of water from any source shall be promptly emptied and the holes filled with dry material. Whenever any portion of the impervious embankment is to stand for one week or longer, during which period no additional layers of material are to be placed thereon, or whenever rainstorms are imminent, the impervious embankment shall, if so ordered, be smooth rolled so as to readily shed water. Such smooth rolling shall not be included in the count of roller passes referred to in Sections 5.10 and 5.14. Before work is resumed on any such portion, it shall be scarified, moistened or dried as required, and recompacted as specified in Section 5.2 so that a tight bond will be obtained with the next layer to be placed. Compacted embankment that may be damaged by washing or otherwise shall be acceptably replaced by the Contractor without direct compensation therefor.

Smooth  
rolling.

SECT. 5.10 After each embankment layer has been spread to the required thickness and its moisture content has been adjusted, as necessary, to within the required limits, it shall be rolled as specified. Not less than four passes of a 50-ton rubber-tired roller will be required on every portion of each layer of both impervious and semi-pervious embankment. In case embankment of either type deforms and weaves excessively, in the opinion of the Engineer, under the roller or under trucks and other equipment, it will be evident that either the required degree of compaction is not being attained and that an adjustment in the moisture content is required or the pore pressures in the embankment are too great. If such deformation and weaving produce surface cracks and are of such character, amount, or areal extent as, in the opinion of the Engineer, to indicate an unfavorable condition, he will order operations on that part of the embankment to be suspended until such time as the condition of the embankment is satisfactory for the resumption of operations. Adjustment of the weight of the roller may be ordered by the Engineer in order to obtain the required compaction. As far as practicable, the Contractor shall keep the rolling operations spread out over a reasonably large area. Successive roller passes over the same portion of a layer shall be offset and adjacent roller passes shall overlap each other sufficiently to insure uniform compaction. If, over any

Rolling  
of layers.

Deformation  
and weaving.

**Insufficient  
compaction.**

area, the compaction obtained, as determined by the Engineer, is less than that obtained by the usual procedures in handling and compacting the materials, because of insufficient overlap, too thick layers, too much or too little moisture, or other cause attributable to improper work, the condition shall be remedied and, if additional rollings are therefore ordered, payment will not be made as specified under Section 5.14. If the material itself is unsatisfactory, or if additional rolling or other means fail to produce satisfactory results, the area in question shall be excavated to material of satisfactory density and the excavating, replacing, and rerolling shall be done by the Contractor without additional compensation.

**Rubber-tired  
rollers.****Modification  
of rollers.**

SECT. 5.11 Rubber-tired rollers shall have a minimum of four wheels equipped with pneumatic tires. The tires shall be of such size and ply as can be maintained at tire pressures between 80 and 100 pounds per square inch for a 25,000-pound wheel load during rolling operations. The roller wheels shall be located abreast and be so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels shall be such that the distance between the nearest edges of adjacent tires will not be greater than 50 percent of the tire width of a single tire at the operating pressure for a 25,000-pound wheel load. The roller shall be provided with a body suitable for ballast loading such that the load per wheel may be varied, as directed by the Engineer, from 18,000 to 25,000 pounds. The roller shall be towed at speeds not to exceed ten miles per hour. The type, design, and details of rollers shall be subject to the preliminary approval of the Engineer before their employment on the work. As experience is gained in the compaction of the materials available for the embankment, certain changes in the details of the rollers may be indicated to improve their efficiency in securing the degree of compaction specified or in obtaining greater uniformity or increased speed of operation. To attain these ends the Contractor shall make such alterations in the details of the rollers as ordered or permitted without payment therefor other than is included in the prices stipulated for Items 5 and 6.

**Special  
methods  
of com-  
pacting.**

SECT. 5.12 Wherever, because of the topography, existing structures, or other conditions, the required compaction cannot be obtained by the use of the rollers specified in Section 5.11 or where the use of such rollers is prohibited, compaction shall be by approved hand-operated, power-driven mechanical tampers, approved rollers of lighter weight, or other approved compacting equipment. Compaction by approved hand-operated, power-driven mechanical tampers will be required for compacting embankment in



places where the required compaction cannot be obtained by the use of other approved compacting equipment. The rollers specified in Section 5.11 will not be permitted to pass over any portion of the diversion or release water conduits until at least four feet of embankment have been placed thereon and compacted by approved compacting equipment of sufficiently lighter weight. Materials to be compacted by equipment other than the rollers specified in Section 5.11 shall be spread in layers not more than six inches thick for either type of embankment, measured before compaction, and the degree of compaction attained by these compacting operations shall be equal in every respect to that secured by the said rollers. No payment will be made for furnishing, placing, and compacting embankment that is compacted by special compacting equipment as specified in Section 5.12, except as such payment is included under Item 5 for rolled impervious embankment or Item 6 for rolled semi-pervious embankment, as appropriate.

SECT. 5.13 The embankment shall be built to such height, as shown on the drawings or ordered, as will, in the opinion of the Engineer, allow for subsequent shrinkage and settlement. All material placed and compacted within the limits ordered or designated by the Engineer will be estimated for payment as specified in Section 5.15 but no payment will be made for material outside such limits.

Allowance  
for settle-  
ment.

SECT. 5.14 In case it should become necessary, in order to obtain the required degree of compaction, to do more rolling on any or all of the embankment layers than the four passes specified in Section 5.10, the Contractor shall do such additional rolling as the Engineer may order. For each ordered additional pass of a 50-ton roller, the quantity of embankment measured for payment under Item 5 or 6 shall be increased by two percent of the volume of the layer or part thereof rolled by each such additional pass. The volume of rolled embankment to be increased under the provisions of this section shall be the computed volume of the layer or part thereof which has been rolled by more than four roller passes, the thickness of the layer always being taken as 10 inches for impervious embankment and 17 inches for semi-pervious embankment. The number of roller passes shall be computed as though there were no overlaps in rolling and shall not include rolling done in turning the equipment at the ends of the lanes or such rolling parallel to the abutments as may be needed to secure the required degree of compaction in the embankment at and near the junction between it and the abutments.

Additional  
rolling.

**Measurement  
and payment.**

SECT. 5.15 The quantity to be paid for under Item 5 shall be the number of cubic yards of rolled impervious embankment measured in final position from the surface of the foundation as prepared in accordance with orders, from the surface of the key trench, or from the surface of existing masonry, to the limits of the rolled impervious embankment shown on the drawings or designated in writing by the Engineer. The quantity to be paid for under Item 6 shall be the number of cubic yards of rolled semi-pervious embankment measured in final position from the surface of the foundation as prepared in accordance with orders, from the ordered surface of rolled impervious embankment, from the surface of existing embankments, or from the surface of existing masonry, to the limits of the rolled semi-pervious embankment shown on the drawings or designated in writing by the Engineer. The number of cubic yards of rolled embankment measured for payment under Items 5 and 6 shall be increased because of ordered additional roller passes, as provided in Section 5.14. There shall also be measured for payment under Items 5 and 6, as appropriate, the numbers of cubic yards of impervious and semi-pervious embankment materials, respectively, measured in final position required for filling test pits excavated under Item 3 and for filling holes and depressions in the dam foundation as specified in Section 5.2. The prices per cubic yard stipulated for these items shall include all labor, plant, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under these items in the manner herein set forth and specified. No payment will be made for excavations in borrow pits or from storage piles to provide materials to be placed under Items 5 and 6 except as included in the prices stipulated for Items 5 and 6. Where materials from ordered excavations under Item 3 are used in semi-pervious embankments placed under Item 6, payment for excavation will be made as specified under Item 3 and payment for semi-pervious embankment will be made under Item 6 as specified herein.

**REFILLING AND EMBANKING****ITEM 7****Work  
included.**

SECT. 7.1 Under Item 7 the Contractor shall do all required refilling and embanking, except the rolled embankment for the dam under Items 5 and 6, rock embanking under Item 8, surface dressing under Item 11, and run of bank gravel under Item 25, to the lines shown on the drawings or ordered, for covering the surfaces of rock embanking on the downstream slope of the dam, for covering surfaces of spoil banks, for sewage treatment plants, for plants for the treatment of pumpage and drainage except



at borrow pits for materials other than those required for Items 5 and 6, for the sites of buildings removed under Item 2, for repair of the existing access roads, for construction of additional permanent access roads, for reconstruction of a portion of the town road, for test pits, sewers, drains, and pipes, for fences and guard rails as specified in Section 15, for grading, and for other contract purposes, as ordered. As a part of the work under this item, the Contractor shall repair any settlement, sliding, or washing of refills and embankments made by him until the completion and acceptance of the work under this contract, without other compensation than that provided herein for refilling and embanking to the ordered lines, and shall place and maintain temporary pavements or surfacing over all trenches in roadways and elsewhere, as required, to take care of traffic. No material placed outside the prescribed lines for refilling and embanking shall be included under this item, even though such material may have been placed, with the permission of the Engineer, immediately adjacent to or contiguous with the prescribed refilling and embanking. This item shall not include any refilling and embanking for any cofferdam or dike constructed under Item 47, for temporary water supplies, for the Contractor's temporary buildings or plant, for the temporary storage of excavated materials, for temporary roads, dikes, drains and sumps, or for other temporary structures of the Contractor, except as provided in Sections 14 and 15.

SECT. 7.2 Refills and embankments may be made of materials from the excavations under Items 3 and 4, in so far as they are acceptable, or borrow pits on lands of The City or provided by the Contractor from other sources outside the limits of the work. All materials used for refills and embankments shall be free from frost, stumps, large roots, ashes, oil, and other perishable or foreign matter. Earth for covering the surfaces of rock embankments shall contain a minimum amount of stones and shall be free from stones larger than six inches in diameter. Rock may be permitted in certain refills and embankments and when so placed shall be measured for payment under this item. The stones forming the faces of such embankments shall be of suitable shapes and sizes, and shall be placed to the prescribed lines as required.

Materials for  
refilling and  
embanking.

SECT. 7.3 All embankments shall be started on a firm foundation from which soil, stumps, large roots, and other perishable material and earth loosened by freezing shall have been removed to the extent directed, and if, where a soil cover is to be placed, the depth of fill is less than two feet, oil, ashes, and other foreign matter shall first be excavated as ordered.

Foundations  
for embankments.

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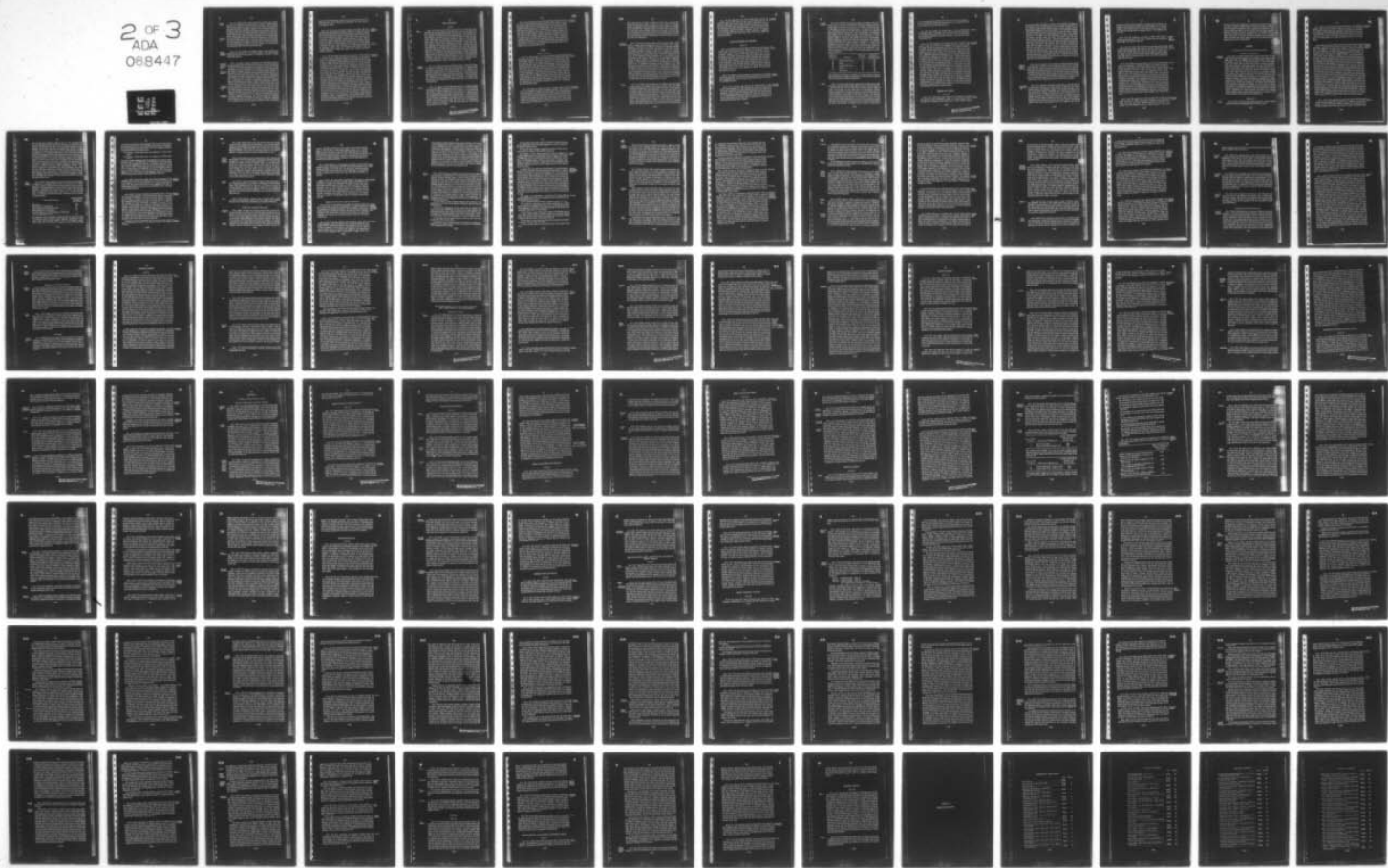
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NATIONAL DAM SAFETY PROGRAM. CANNONVILLE DAM,  
JUL 78 R J KIMBALL

F/G 13/2  
INVENTORY NUMBER--ETC(U)  
DACW51-78-C-0025

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ADA  
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Refilling  
trenches.

SECT. 7.4 Before pipes or drains are laid in a trench in rock, unless they are to be supported on concrete saddles or cradles, or surrounded with crushed stone, gravel, or sand, the bottom of the trench shall be refilled with approved material thoroughly compacted to the elevation directed. Refilling of trenches for pipes, drains, and other structures shall be deferred, if ordered, until after any required hydrostatic tests shall have been completed. Other trenches and excavations shall be refilled as soon as practicable after the pipes, drains, and other structures have been satisfactorily laid or constructed therein. Unless otherwise permitted, the material shall be placed in horizontal layers not over four inches thick and each layer shall be sprinkled and thoroughly compacted. No stone shall be placed in the refill nearer than four inches to any pipe. Special care shall be taken in compacting refills around the various structures.

Compacting  
refills.

Temporary  
roads in-  
corporated in  
embankments.

SECT. 7.5 Any portions of temporary access or other roads of the Contractor that are not above the ordered surfaces of the earth embankments shall be included for payment as embankment under Item 7 if made of suitable material.

Embankments  
to be carried  
up level to  
prescribed  
lines.

Modifications  
may be per-  
mitted.

Consolidation  
of embank-  
ments.

Settlement to  
be repaired.

SECT. 7.6 Unless otherwise permitted, the embankments shall be carried up approximately level and built to the lines shown on the drawings or ordered. The earth embankment for covering the surfaces of the rock embanking on the downstream slope of the dam shall be deposited in layers and shall be uniformly compacted by the hauling equipment. Portions of embankments may be permitted to extend beyond the prescribed lines, but material placed outside of such lines will be considered as deposited in spoil banks or disposed of beyond the limits of the work, as prescribed under Section 12, and no payment will be made therefor under Item 7. So far as practicable, the rock fills in embankments shall be so selected, graded, and placed that the volume of voids in the embankments shall be a minimum and the Contractor will be required to flush earth into such voids as may unavoidably occur in the upper portions of the rock fills. Earth embankment placed over rock fill shall be not less than one foot in thickness after complete consolidation and after all settlement into the underlying rock fill shall have occurred. When time for natural settlement is not available, the Contractor shall roll or tamp the earth embanking material in layers of approved thicknesses. Any settlement, sliding, or washing of embanking materials after placing, that may occur before the completion and acceptance of the work under this contract, including the settlement of the earth into the rock fill, shall be remedied and the embankment

brought to the required grade without other compensation than that provided under this item for refilling and embanking to the lines shown on the drawings or ordered.

SECT. 7.7 As soon as a section of trench in any public road, or in any other place where required, has been refilled and all plant and excess materials have been removed, a temporary pavement or surfacing shall be laid over the trench and it shall be satisfactorily maintained, under this item, until the permanent pavement is laid. Broken stone, gravel, pieces of concrete, or other acceptable material taken from the trench shall be placed as a temporary surfacing, or the Contractor shall furnish and place broken stone, gravel, or steam cinders for this purpose, as may be ordered or approved. As a part of the maintenance of the temporary surfacing over the trenches in public roads, the Contractor shall furnish water and sprinkle sufficiently to compact the surface of the trenches and prevent annoyance from dust.

Temporary  
surfacing over  
trenches.

Sprinkling.

SECT. 7.8 The quantity to be paid for under Item 7 shall be the number of cubic yards of compacted refilling and embanking, as described in Section 7.1, including temporary pavements or surfacing, measured in final position, that are actually placed within the limits shown on the drawings or ordered. Refills shall be measured from the limits to which excavation under Item 3 or 4 is measured for payment; embankments, from the surface on which the embanking material is placed. No deductions shall be made under Item 7 for the space occupied by a pipe having a cross-sectional area smaller than three square feet. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. No payment will be made for furnishing materials required for the refills and embankments made under Item 7, in excess of that available from excavations under Items 3 and 4, except in the price stipulated for Item 7. No temporary surfacing or refill in roadways above the established grades will be paid for under Item 7 and no material placed outside the prescribed lines for refill and embankment will be paid for under this item, even though such material in refills and embankments may have been placed, with the permission of the Engineer, immediately adjacent to or contiguous with prescribed refills and embankments, as being a suitable place for the disposal of such materials, payment therefor being considered as having been included in the prices stipulated for the appropriate excavation items.

Measurement  
and payment.



## ROCK EMBANKING

## ITEM 8

Work  
included.

SECT. 8.1 Under Item 8 the Contractor shall furnish and place rock embanking to the lines shown on the drawings or ordered, for portions of the dam, the weir approach channel, the waste and outlet channels, the river channel of the West Branch of the Delaware River, and for other contract purposes, as ordered. As a part of the work under this item, the Contractor shall repair any settlement, sliding, or washing of rock embankments made by him until the completion and acceptance of the work under this contract, without other compensation than that provided herein for rock embanking. No material placed outside the prescribed lines for rock embanking shall be included under this item, even though such material may have been placed, with the permission of the Engineer, immediately adjacent to or contiguous with the prescribed rock embanking. This item shall not include any rock embanking for any cofferdam or dike constructed under Item 47, for temporary water supplies, for the Contractor's temporary buildings or plant, for the temporary storage of excavated materials, for temporary roads, dikes, drains and sumps, or for other temporary structures of the Contractor, except as provided in Sections 14 and 15.

Quality of  
materials.

SECT. 8.2 Rock used for rock embanking shall be composed of durable stones of acceptable sizes, shapes, and grading. The material shall be free from stumps, roots, and other perishable or foreign material. Any rock that includes shale or an excessive amount of fines will not be acceptable. No flat stones having a thickness less than one-third of the least linear dimension of the largest face area shall be left in the rock embanking. Materials for rock embanking may be obtained from ordered excavations, from rock storage piles, and from borrow areas, in so far as they are satisfactory.

## Placing.

SECT. 8.3 Stones for rock embanking shall be so selected, graded, and placed throughout, as directed, that the volume of voids in the embankment shall be a minimum. Where earth is to be placed upon rock embanking, the top portion shall be graded from coarse to fine at the surface to provide a thoroughly filled outer layer of rock embanking to resist settlement and washing of the overlying earth into the rock fill. Material for the protection of slopes, embankments, and channels shall be so placed that the smaller stones shall be at the under side of the rock fill, increasing in size to the top, as directed, so that the greater proportion of the large stones shall be at the surface.

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SECT. 8.4 The quantity to be paid for under Item 8 shall be the number of cubic yards of rock embanking, measured in final position, that are furnished and placed within the limits shown on the drawings or ordered, measured from the surfaces of underlying refills, from the surfaces of embankment placed under Item 6 or 7, from surfaces to which excavation has been made in accordance with orders, or from the original surface if no excavation has been ordered. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. No payment will be made for furnishing rock for embankments in excess of that available from excavations under Item 4 except in the price stipulated for Item 8.

Measurement  
and payment.

### RIPRAP

#### ITEMS 9 AND 10

SECT. 9.1 Under Items 9 and 10 the Contractor shall furnish and place riprap to the lines shown on the drawings or as ordered. Item 9 shall include light riprap for the upstream face of the dam, for portions of the weir approach channel, for slope protection for a portion of the south abutment of the dam, and for other contract purposes, as ordered. Item 10 shall include heavy riprap for protection of a portion of the upstream face of the dam. As a part of the work under this item, the Contractor shall repair any settlement or sliding of riprap placed by him until the completion and acceptance of the work under this contract, without other compensation than that provided herein for riprap. These items shall not include riprap for any cofferdam or dike constructed under Item 47. No material placed outside the prescribed lines for riprap shall be included under these items, even though such material may have been placed, with the permission of the Engineer, immediately adjacent to or contiguous with the prescribed riprap.

Work  
included.

SECT. 9.2 Stones for light riprap shall be sound, durable, and hard rock of established, acceptable weathering qualities when exposed to water, frost, or air and shall be of the sizes, shapes, and grading specified or ordered. Shale, soft or badly weathered stones, distinctly layered sandstones and any other stones which reed or split upon exposure will not be acceptable as materials for light riprap. Light riprap shall be free of perishable and foreign materials and shall not contain any stones small enough to pass a 2-inch ring. At least 50 percent of the volume of light

Materials for  
light riprap.



riprap shall consist of stones exceeding one cubic foot in volume. The stones for light riprap shall be angular in shape, except that rounded boulders and cobbles may be used provided they are otherwise acceptable and are included with a sufficient number of angular stones to give stability to the entire mass of riprap. No flat stones having a thickness less than one-third of the least linear dimension of the largest face area shall be used. Materials for light riprap may be obtained from ordered excavations, from quarries, from rock storage piles, and from borrow areas in so far as they are satisfactory.

**Materials for  
heavy riprap.**

SECT. 9.3 Stones for heavy riprap shall be sound, durable, hard, massive, angular, quarried fragments of granite, diabase, basalt, diorite, limestone, or dolomite of established, acceptable weathering qualities when exposed to water, frost, or air, and shall be of the sizes, shapes, and grading specified or ordered. No soft, badly weathered or distinctly laminated stones will be acceptable. The loss in weight of stone used for heavy riprap shall not exceed 18 percent by weight when subjected to five cycles of the magnesium sulfate soundness test in accordance with the requirements of the Tentative Method of Test for Soundness of Aggregates by Use of Sodium Sulfate or by Magnesium Sulfate, ASTM Designation: C88-59T, of the American Society for Testing Materials. Heavy riprap shall be free of perishable and foreign materials. Samples of the stone proposed to be used for heavy riprap shall be furnished to the Engineer for his approval. None of the stones in the heavy riprap shall be smaller than one cubic foot and at least 50 percent of the volume shall consist of stones exceeding one-half cubic yard in volume. No flat stones having a thickness less than one-third of the least linear dimension of the largest face area shall be used. Rounded boulders and cobbles, and stones from the excavations for the contract structures and from quarries in the vicinity of the work will not be acceptable for heavy riprap.

**Placing.**

SECT. 9.4 Riprap shall be placed to the thickness and extent shown on the drawings or as ordered. The average surface of the riprap shall satisfactorily approximate the required theoretical surface. Stones shall be so selected, graded, and placed throughout, that the riprap shall be an interlocked stable mass and the volume of voids in the embankment shall be a minimum. Material for riprap shall be so placed that the small stones shall be at the underside of the embankment, increasing in size to the top, as directed, so that the greater portion of the large stones shall be at the surface. The Contractor will be required to place riprap by hand or by otherwise setting individual stones only as may be necessary to rearrange stones to fill voids or depressions or to interlock loose or unstable stones.

SECT. 9.5 The quantities to be paid for under Items 9 and 10, respectively, shall be the number of cubic yards of light riprap and the number of cubic yards of heavy riprap, measured in final position, that are furnished and placed within the limits shown on the drawings or ordered. The prices per cubic yard stipulated for Items 9 and 10, respectively, shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under these items in the manner herein set forth and specified.

Measurement  
and payment.

## SURFACE DRESSING AND GRASSING

### ITEM 11

SECT. 11.1 Under Item 11 the Contractor shall furnish and place acceptable top soil as dressing for the surfaces of excavations, embankments, refills, spoil banks, and other areas, except such areas as will be eventually covered by water, to the extent and thickness shown on the drawings or as ordered. He shall also, under this item, fertilize and seed or sod these areas and maintain them until the completion and acceptance of the entire work. In general, these areas include, but shall not necessarily be limited to, the downstream surface of the dam, slopes in the vicinity of the weir, waste, and outlet channels, slopes of access roads, and other graded areas in the vicinity of the work. Except where a 12-inch depth of top soil is shown on the drawings or ordered, the depth of top soil will be six inches.

Work  
included.

SECT. 11.2 Subject to such conditions and restrictions as the Engineer deems necessary, the Contractor will be permitted to remove top soil from designated areas within the reservoir flow line upstream of the dam for use under this item.

Material  
for surface  
dressing.

SECT. 11.3 In general, soil shall not be deposited until, in the opinion of the Engineer, any refill, embankment, or spoil bank upon which it is to be placed shall have approximately reached its final condition of settlement, or until satisfactory provision shall have been made for possible future settlement. Wherever necessary, the surface upon which the soil is to be placed shall be raked or otherwise satisfactorily prepared to insure a proper bond. The soil shall then be deposited to the thickness directed and acceptably rolled or tamped.

Preparation  
and placing.



**Fertilizing  
and seeding.**

SECT. 11.4 After the soil has been placed in accordance with Section 11.3 and at such time as the Engineer shall order or approve, the Contractor shall place evenly on the areas to be seeded or sodded, and rake in thoroughly, an approved chemical fertilizer at the rate of two tons per acre. The fertilizer shall be of 5-10-5 analysis and shall be a brand licensed and registered with the New York State Department of Agriculture and Markets. After the fertilizer has been applied, grass seed shall be sown uniformly at the rate of six bushels per acre and shall be satisfactorily raked in. The areas thus seeded shall then be satisfactorily rolled. Any portions of The City's lands on which grading is not required, but from which the turf has been removed or damaged as a result of the Contractor's operations, shall be resoiled if necessary, or spaded and likewise fertilized and seeded. Grass seed shall be of high grade commercial stock of the previous year's crop with a weed content not to exceed one percent and shall conform to the following analysis or an approved equivalent:

PERCENT BY WEIGHT	VARIETY	PERCENT PURITY	PERCENT GERMINATION
50	Kentucky Blue Grass .....	85	80
20	Redtop .....	95	90
15	Domestic Rye Grass .....	95	85
10	Timothy .....	99	90
5	White Clover .....	97	90

The Contractor shall furnish a certificate of analysis and test from an approved laboratory showing that the seeds have been recently tested and meet all requirements of these specifications.

**Sodding.**

SECT. 11.5 Sound sods having a good quality of heavy grass shall be placed on gutters or berms except where paved, and, wherever required, a strip not less than one foot wide shall be placed along the edges of areas to be seeded, or on such other parts of the excavations, embankments, or graded areas as directed, or where, in the opinion of the Engineer, washing is likely to occur before the seed has taken root. After the areas to be sodded have been brought to the ordered subgrade and fertilized, sods of a good quality of heavy grass, cut in squares from 12 to 15 inches each, and of a uniform thickness of at least 1½ inches, shall be properly laid with a fair bearing and a smooth, even surface and beaten down firmly. On slopes and elsewhere, as directed, each sod shall be secured by at

least two wooden pegs of ordered length. The total area to be sodded under this item shall not exceed five percent of the entire seeded and sodded areas on which soil is placed under this item.

SECT. 11.6 All seeded and sodded areas shall be satisfactorily cared for and watered and the grass cut, as directed, until the completion and acceptance of the work under this contract. Portions of these areas shall be resoiled, refertilized, reseeded, or resodded, if required, to obtain a satisfactory result. Maintenance.

SECT. 11.7 The quantity to be paid for under Item 11 shall be the number of cubic yards of soil of the required thickness, measured after compacting, that are actually placed, fertilized, and seeded or sodded in accordance with the requirements of these specifications within the limits specified in Section 11.1, except that the Contractor shall make good, without additional payment therefor, any considerable settlement of any refill or embankment below the established lines and grades that shall take place before the completion of the entire contract. Surface dressing and grassing on areas satisfactorily seeded or sodded under Item 11 shall be included for payment in the final estimate although a good stand of grass may not then have been established, provided all work on such areas was done in accordance with the requirements of the specifications. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. Payment for resoiling, seeding, or sodding any lands beyond the limits of the ordered operations of the Contractor will be included under Item 49. No payment will be made under Item 11 for resoiling, spading, fertilizing, seeding, sodding, or otherwise restoring any portion of the prescribed areas on which regrading is not required but on which the turf has been removed or damaged as a result of the Contractor's operations or for any required surface dressing and grassing in a borrow pit area. Measurement and payment.

## TIMBER AND LUMBER

### ITEM 12

SECT. 12.1 Under Item 12 the Contractor shall furnish all material for, build, and leave permanently in place or maintain in good order as directed for the duration of this contract, unless sooner ordered removed, Work included.

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structures of timber and lumber, as ordered, comprising but not limited to the housing over any ordered extension to the intermittent sand filters of the existing sewage treatment plant, buildings to house equipment for the application of chemicals in any ordered plants for the treatment of pumpage and drainage except at borrow pits for materials other than those required for Items 5 and 6, structures as specified in Sections 14 and 15, ordered barricades in connection with field radiography of welds, ordered signs and notices, and other timber and lumber work ordered under this item. These structures shall be erected in accordance with approved drawings. As a part of the work under this item, the Contractor shall furnish all hardware, paint, nails, bolts, nuts, washers, spikes, and other fastenings and shall paint and repaint as directed any surface structures erected under this item and visible to the public, including ordered signs and notices thereon. Under this item, also, the Contractor shall furnish and place as required for the structures erected under this item, doors, windows, screens, storm windows, 90-pound felt roofing, and 15-pound felt for walls. Sheeting and bracing in excavations shall also be included in this item to the extent that such sheeting and bracing shall be of approved design and shall have been ordered left in place.

Timber and  
lumber not  
included  
under Item 12.

SECT. 12.2 No timber or lumber shall be included under Item 12 that is not described in Section 12.1 nor specifically ordered to be furnished under this item. Timber and lumber required for stream control, for maintaining the upstream bridge and the City's buildings and other facilities to be maintained under this contract, for the Contractor's plant and buildings, for forms or other purposes of the Contractor, and for sheeting and bracing in excavations unless of approved design and ordered left in place, shall not be included under Item 12 but shall be considered as having been included in the prices stipulated for the various items of the contract.

Size, quality,  
and workman-  
ship.

SECT. 12.3 All timber and lumber used by order or with the approval of the Engineer shall be of the sizes directed or approved, new, and of suitable quality and sufficient strength for the purposes intended, except that second hand material, if approved, may be used where strength and appearance are not important considerations. If the Contractor is of the opinion that larger or additional pieces of timber or lumber than those ordered should be used in any of the structures, he may, unless otherwise directed, use such larger or additional pieces, but shall not be entitled to payment for any excess over and above the amount ordered. Workmanship shall be first class in all respects and all work shall be done with an

American Society for Testing Materials. Certified copies of reports of the properties of the materials supplied shall be furnished and, if directed, samples of the material used in the work shall be furnished for physical and other tests and delivered at designated points at the expense of the Contractor.

SECT. 13.3 The dimensions and types of rubber water stops, including any required unions, ells, tees, or crosses, shall be as shown on the drawings or as ordered or approved.

Size and  
type of  
rubber  
water stops.

SECT. 13.4 All rubber water stops shall be protected against damage in transit and against grease, dirt, mortar, or concrete until placed in final position. The straight strip water stops shall be shipped in rolls, the inside diameter of which shall not be less than 18 inches and shall be crated or wrapped in burlap and tied securely. Before being placed in position, water stops shall be thoroughly cleaned of any dirt or other material that might reduce the bond.

Cleaning  
and  
protecting.

SECT. 13.5 Rubber water stops shall be placed in the exact positions shown on the drawings or ordered, and shall be so securely fastened in position by suitable means, as to prevent displacement while the concrete is being deposited and until it shall have set. Field splices between lengths of water stops and connections to premolded ells, tees, or crosses, shall be made with premolded sleeve type rubber unions and approved rubber cement or by vulcanizing, strictly in accordance with the recommendations of the manufacturer. The procedure for making field splices and connections, description of the equipment required for properly cementing or vulcanizing the splices and connections in accordance with the recommendations of the manufacturer, and details of any special joints, that cannot be made with the standard unions, ells, tees, or crosses, shall be submitted for approval of the Engineer at the time of the submission of the certified copies of reports of the properties of the water stop materials as required in Section 13.2. Each finished splice shall have a tensile strength of not less than 50 percent of the tensile strength of the unspliced material.

Placing.

Splices.

SECT. 13.6 The quantity to be paid for under Item 13 shall be the number of pounds of rubber water stops, including all premolded rubber unions, ells, tees, and crosses, furnished and placed in the work in accordance with the drawings or orders. No separate payment will be made

Measurement  
and payment.



for rubber cement, for vulcanizing, or for materials used for fastening the water stops in position. Weights shall be obtained by weighing, unless in any case payment by theoretical weight is approved for convenience. The price per pound stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to furnish, place, and secure in the work rubber water stops of the kind and quality specified and in the manner herein set forth. Steel plates, bolts, and nuts used in special joints as approved will be paid for under Item 37.

### MASONRY

*See Items 14, 15, 16, 17, 18, 19, 23, 24, 26, and 27*

#### GENERAL CONDITIONS

Description  
of masonry.

SECT. 14G.1 Concrete masonry will be used for the waste weir, the waste channel sills, the gaging weir, the emergency gate tower and the bridge to the tower, the plugging of the diversion conduit and the temporary release water pipe, the lining and envelope of the release water conduit, the release water chamber, retaining walls, footings and foundations, piers, manholes, catch basins, drains, stop logs, settlement measurement plates, posts, and culverts, and for other purposes as may be shown on the drawings or ordered. Stone masonry will be used for facing the low level weir, portions of the weir and waste channels, retaining walls, parapet walls, exposed portions of the emergency gate tower and the release water chamber, and elsewhere as shown on the drawings or ordered. By special permission only, brick or stone masonry may be substituted for concrete in connection with grouting, stopping flows of water, construction of manholes, or for other minor purposes and concrete block masonry may be used for the foundation of any ordered chlorinator house for the treatment of pumpage and drainage. Any brick, stone, or concrete block masonry or mortar used by permission to take the place of concrete masonry in any part of the work shall be measured and paid for as concrete masonry. Stipulations for various materials, specified in the following general sections, apply to such materials wherever used, except in so far as the stipulations are modified in any particular item.

#### MATERIALS

Cement.

SECT. 14G.2 For the masonry required under this contract, Portland cement of the quality specified under Item 24 shall be used.

SECT. 14G.3 For air-entrained concrete masonry, an air-entraining admixture shall be used to obtain the desired air content. The admixture shall conform to the Tentative Specifications for Air-Entraining Admixtures for Concrete, ASTM Designation: C260-58T of the American Society for Testing Materials. Any air-entraining admixture which has been in storage at the site of the work for more than six months or which has been subjected to freezing shall not be used until retest proves it to be satisfactory.

Air-entraining  
admixture.

SECT. 14G.4 Sand and crushed stone or gravel from sources that are specifically approved for this contract may be used for concrete aggregates. The Contractor, as required by the Engineer, shall have such tests made as necessary to determine whether or not any proposed source is acceptable. The tests to which the aggregates shall be subjected are specific gravity, absorption, Los Angeles abrasion, soundness in magnesium sulfate, quick chemical for alkali-reactivity, and petrographic examination. This testing shall be performed by an approved testing laboratory and a qualified petrographer. After the necessary washing, processing, and handling, the aggregates produced shall meet all the requirements of Section 14G.5 for fine aggregate and Section 14G.6 for coarse aggregate. The continued use of any source of aggregates will be approved only if its materials are properly processed to produce clean aggregates free from clay, soft particles, and other unsatisfactory materials as specified herein. The Contractor shall submit for approval of the Engineer the layout of the plant and a description of the equipment and its functioning. Special care shall be taken in the operation of a plant to eliminate deleterious particles and keep the amount of such particles within the specified limits, by hand picking as needed. Any source of aggregates and the plant for removing and processing of materials therefrom will be subject to continuous inspection by the Engineer and frequent samples will be taken of the sand and crushed stone or gravel before and after processing and also at the batching plant in order to determine if the sand and crushed stone or gravel continue to be of the quality that will produce aggregates complying with the specifications. If such is not the case and the product cannot be made to meet the specifications through selection of materials or improvements in the methods of washing, processing, and handling, the source will be disapproved and aggregates from such source will be rejected.

Sand and  
crushed stone  
or gravel for  
aggregates.

SECT. 14G.5 Fine aggregate for concrete and mortar shall be natural sand of such acceptable size and quality as are approved. All sand shall consist of clean, hard, strong, durable, insoluble, and uncoated particles. It shall contain not more than one percent by weight of vegetable matter,

Fine  
aggregate.



nor more than three percent by weight of clay, or silt, and shall be free from such quantities of other deleterious substances as will render it unsuitable. All sand shall be made clean by thorough washing. Any fine aggregate which breaks down into unacceptably fine material on boiling in water for two hours, or ten percent or more of the dry weight of which is soluble in a 1 to 1 solution of hydrochloric acid in 15 minutes, shall be rejected. Fine aggregate shall contain both fine and coarse particles, with none larger than will pass a 1/4-inch mesh sieve, and with such gradation in sizes of particles as will produce smoothly working concrete without tendency for the water to drain away. In general, sands containing an excess of fine grain sizes will not be acceptable. Fine aggregates shall be tested in conformity with the Tentative Method of Test for Organic Impurities in Sands for Concrete, ASTM Designation: C40-56T, of the American Society for Testing Materials. Those producing a color darker than the reference standard color solution shall be rejected unless the discoloration is due to the presence of small quantities of coal or lignite. Fine aggregate shall also be subject to tensile and compressive mortar tests, and shall show strengths not less than those of similar tests made with graded Ottawa sand.

Coarse  
aggregate  
or ballast.

SECT. 14G.6 Coarse aggregate for concrete shall be approved gravel or fragments of acceptable stone broken to such sizes as are herein specified. A mixture of broken stone and gravel may be used, but only as permitted. Coarse aggregate shall consist of clean, hard, strong, durable, insoluble, unweathered, and uncoated pieces; it shall be free from such alkali, decomposed minerals, organic material, mica, or schist that will render it unsuitable; and other deleterious substances shall not exceed the following limits:

Deleterious Substance	Maximum Percent by Weight of Total Sample
Clay lumps .....	0.25
Soft particles, including shale .....	5.0
Thin, elongated, or laminated particles .....	4.0
Material finer than No. 200 sieve .....	1.0
Saturated-surface-dry material floating on a liquid having a specific gravity of 2.0 .....	1.0

The aggregate shall be thoroughly washed and shall be clean at the time it is mixed in concrete. Pieces of coarse aggregate, approximately 1-inch cubes, shall, when immersed in 600 c.c. of a 1 to 1 solution of hydrochloric acid, show a loss from their original dry weight of not more than

ten percent in 45 minutes. Coarse aggregate shall be of the sizes suited to the various parts of the work and shall be kept separate according to size before being used in the concrete. The coarse aggregate shall be stored and batched in the following sizes:

- (1) Passing a 1½-inch mesh sieve and retained on a ¾-inch mesh sieve.
- (2) Passing a ¾-inch mesh sieve and retained on a ¼-inch mesh sieve.

Each size of coarse aggregate shall be graded from fine to coarse within the limits shown, to the satisfaction of the Engineer. A greater maximum size for coarse aggregate may, however, be required in some parts of the work, while in others the maximum size may not be permitted to exceed ¾ inch. Each size of coarse aggregate and the fine aggregate shall be kept in separate hoppers or bins, and any mixture of fine and coarse aggregates, or of each size of coarse aggregate, delivered to the work shall be screened and remixed in ordered proportions before use.

SECT. 14G.7 The storage, loading, and batching of aggregates at the aggregate processing plant, the batching plant, or elsewhere shall be done in such manner as to prevent segregation or the inclusion of foreign materials. The sand and the smaller size of coarse aggregate shall remain in free-draining storage for at least 72 hours immediately prior to placement in the batching plant bins.

Storage and  
handling of  
aggregates.

SECT. 14G.8 The name and location of operating sources, and samples of processed aggregates, which the Contractor proposes to use shall be submitted to the Engineer at least four weeks before the Contractor plans to commence delivery at the site of the work. Samples of materials from proposed unopened sources shall be accompanied by a topographic map showing the location and details of borings or test pits. The exploration of such proposed new sources, the testing and evaluation of the materials, and the details of the processing plant shall be subject to the approval of the Engineer. Samples of fine aggregate (about two gallons) shall be submitted in approved containers, and samples of not less than two cubic feet of each size of coarse aggregate in suitable boxes or bags. All samples shall be collected in the presence of the Engineer and shall be plainly and neatly labeled with the place from which taken, where proposed to be used, the date, and name of collector.

Samples of  
aggregates.

Aggregates shall not be delivered until the source has been approved and, as delivered, they shall in all respects be equal to the approved samples.

Delivery of  
aggregates.



**Bricks.**

SECT. 14G.9 Bricks shall be new, red, solid not cored, clay or shale common bricks complying with the requirements of the Standard Specifications for Building Brick (Solid Masonry Units Made from Clay or Shale), ASTM Designation: C62-58, Grade SW, of the American Society for Testing Materials. Samples of the bricks the Contractor proposes to use shall be submitted for approval before any bricks are delivered on the work.

**Stones for stone facing, rubble masonry, and paving.**

SECT. 14G.10 Stones for stone facing and for rubble masonry and paving shall be sound and durable and of established, acceptable weathering qualities, and of sizes and shapes appropriate to the particular work in hand, as specified or ordered. No slates, shales, nor any other stones which reed or split upon exposure shall be used. Stones for use on exposed faces shall be selected for color, texture, and harmony of appearance throughout the entire work. Stones for use in copings and at other points, as specified or ordered, shall be specially selected for quality and dimensions. The stones shall be thoroughly cleaned before being brought to the place where they are to be used and shall be satisfactorily clean and wet when placed in the masonry.

**Concrete blocks.**

SECT. 14G.11 Concrete blocks shall comply with the requirements of the Standard Specifications for Hollow Load-Bearing Concrete Masonry Units, ASTM Designation: C90-59, Grade A, of the American Society for Testing Materials, and shall be of approved shapes and sizes. Samples of the concrete blocks the Contractor proposes to use shall be submitted for approval, and no blocks shall be delivered on the work unless they have been approved.

**Water.**

SECT. 14G.12 Water for concrete, mortar, and grout shall be clean and free from objectionable mineral salts, and suitable means shall be provided by the Contractor for controlling and accurately measuring it.

**FORMS FOR CONCRETE MASONRY****Construction of forms.**

SECT. 14G.13 All forms for concrete masonry shall be made of approved materials that will give the finished surface required and for repeated use shall be made of metal unless otherwise approved. Forms shall be true to the required shapes and sizes, and shall be strong and rigid so as to withstand without deformation all operations incidental to the placing of the concrete. The forms when erected shall be watertight; any caulking with oakum or other material found necessary shall be done and suitable materials and tools therefor shall be provided. The smoothest practicable finished surface of the concrete will be required wherever it is part of a

**Surfaces of forms.**

waterway. Suitable and effective devices shall be used to hold adjacent edges or ends of panels or other forms tightly together and in accurate alignment and in all cases to hold the forms tightly against the concrete which has been placed previously. All rods or wire ties that are allowed to remain in the concrete shall be removed to such depths from the face of the concrete as shall be ordered or approved, and the holes shall be immediately filled with cement mortar. Ties.

SECT. 14G.14 Wherever it is necessary to lead pipes or other articles through the forms, the Contractor shall drill holes through the forms at any required positions. If the forms are to be used again, satisfactory plugs that fill the holes flush with the face of the forms shall be provided and panels in which too many holes have been made shall be replaced, as required. Holes through forms.

SECT. 14G.15 The forms shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity, watertightness, and smoothness of surface. The Contractor shall keep all forms clean and in good repair and shall furnish and apply, as ordered, any soap, mineral oil, cold-water paint, or other approved lubricant or antiadhesive coating. Directions as to the time of removing forms shall be strictly followed, and this work shall be done with great care, so as to avoid injury to the concrete or damage to any details. Forms unsatisfactory in any respect shall not be used and, if condemned, shall be immediately removed from the work. Maintenance and removal.

#### MIXING AND PLACING CONCRETE MASONRY

SECT. 14G.16 At the earliest date possible, the Contractor shall submit in writing, for the approval of the Engineer, a complete description of the equipment and methods he proposes to use for batching, mixing, transporting, placing, and curing the concrete. He shall have tools, machinery, appliances, and all materials on hand by the time they may possibly be needed, so that concrete can be placed promptly to meet the construction requirements. Concreting appliances and materials to be approved and in readiness.

SECT. 14G.17 Concrete shall be made of cement, water, fine and coarse aggregates, and, where ordered, an air-entraining admixture of the qualities herein specified, combined in the proportions directed from time to time. In general, it will be mixed in the proportions of one volume of cement to about four to six volumes of the aggregates. The proportions of fine and coarse aggregates shall be determined by weight, unless other- Proportions.



wise permitted for small quantities under special conditions. The accuracy of the weighing devices shall be established at the expense of the Contractor by satisfactory tests. Allowance shall be made for variations due to moisture in the aggregates. In determining the proportions of the ingredients, 105 pounds of cement will be considered a cubic foot. The total calculated air content of air-entrained concrete, as determined by the Engineer, shall be between four and seven percent of the volume of the concrete based on measurements made on concrete immediately after discharge from the mixer. The quantity of air within this range shall be as directed and shall be changed whenever such change is determined by the Engineer to be necessary to meet the varying conditions encountered during the progress of the work. The Contractor shall submit for approval plans of the proportioning devices he proposes to use.

Batching  
plant.

SECT. 14G.18 Except as permitted in special cases and for relatively small quantities, the ingredients for concrete shall be proportioned at an approved automatic batching plant in which the batch weights are set manually, the mixes are changed manually, and the materials are batched automatically. The cement, water, and the amount of each separate size of aggregate entering each batch of concrete shall be determined by direct weighing equipment furnished by the Contractor and approved by the Engineer. The batching plant shall be so arranged that the operator may conveniently observe and inspect the operation of the bin gates, the materials in each weighing hopper, the weighing equipment, and the recorders. The batching controls shall be so interlocked that a new batching cycle cannot be started until all weighing hoppers are empty. Suitable facilities shall be provided for obtaining representative samples of the aggregates. The weighing equipment for the aggregates and the cement shall comply with the following requirements:

Weighing  
aggregates  
and cement.

(1) The accuracy of the weighing equipment shall conform to the requirements of the United States Bureau of Standards. Spring scales will not be permitted.

(2) Each size of aggregate and the cement shall be weighed separately and each unit shall include an under and over weight indicator. The underweight indicator shall indicate the filling of the last 200 pounds of the batch. The overweight indicator shall indicate overweight to a maximum of 50 pounds. Both shall be graduated in a clear and legible manner.

(3) The under and over weight indicators shall be in full view of the operator when he is at the controls.

(4) Suitable means of adjustment shall be provided for readily compensating for the varying weight of moisture contained in the aggregates, or for changing the batch weights.

(5) The weight of the cement shall be controlled to within one percent and the weights of the fine and coarse aggregates to within two percent of the required weights for each.

(6) Provision shall be made to permit the convenient removal of overweight material in excess of the prescribed tolerances.

The quantity of water entering each batch shall be weighed by a suitable weighing device of a type approved by the Engineer and capable of weighing the water in variable amounts within a tolerance of one percent. The mechanism shall be capable of being locked in position so as to deliver any specified amount of water to each batch. A positive quick-acting valve shall be used for a cut-off in the water discharge line. The operating mechanism must be such that leakage will not occur when the valves are closed.

Weighing  
water.

A suitable device for measuring and dispensing the air-entraining admixture shall be provided. The air-entraining admixture shall be added to the batch in solution in a portion of the mixing water. The amount of the solution added to each batch shall be controlled by accurate measurement and the solution shall be dispensed in such a manner as will insure uniform distribution of the admixture throughout the batch during the specified mixing time. The device shall be capable of ready adjustment to permit varying the quantity of admixture to be added to each batch. The dispenser for the air-entraining admixture shall be interlocked with the batching and discharging operations of the water so that the batching and discharging of the admixture will be automatic. When truck mixers are used, the solution containing the air-entraining admixture shall be introduced into the mixing water tank of the truck mixer or, if approved, it may be introduced with the sand.

Measuring  
and dispensing  
air-entraining  
admixture.

The weight of the ingredients in each batch of concrete shall be recorded graphically by one or more approved recorders conforming to the following detailed requirements:

Recorders.

(1) The recorders shall be housed in a cabinet provided with a lock.

(2) A printed or autographic record shall be produced on a visible chart or tape of the weights of the cement, water, sand, and each size of coarse aggregate in each batch. After each discharge of the batcher, each recording pen shall return to zero reference.

(3) The charts or tapes shall clearly indicate the different types of mixes used by stamped letters, numerals, colored ink, or by other suitable means. The charts or tapes shall be so marked that variations in batch weights of each type of mix can be readily observed.

(4) The charts or tapes shall show time of day, stamped or pre-printed, at intervals of not more than 15 minutes.

(5) The recorded charts or tapes shall become the property of The City.



**Testing  
of batching  
equipment.**

The Contractor shall provide standardized metallic weights for testing the accuracy of all weighing equipment and shall test the cement and water scales at least once daily and the other weighing equipment at least once weekly. The accuracy of the equipment for measuring and dispensing the air-entraining admixture shall be tested daily when such admixture is used. The recorders shall be maintained so that they are continuously in good operating condition. All tests shall be conducted in the presence of the Engineer. Should any of the batching plant equipment fail to meet the accuracy requirements specified, further proportioning of the ingredients for concrete will not be permitted until satisfactory corrective measures shall have been taken.

**Mixing.**

SECT. 14G.19 Concrete shall be mixed in approved mechanical mixers of a type which dumps the mix before recharging, except that if permitted, and if the mixing is done in a satisfactory manner, relatively small quantities may be mixed by hand. Mixing shall be in batches of the sizes directed and shall be thorough and continued, as directed, until every particle of coarse aggregate is covered with mortar of cement and fine aggregate. The mixers and transporting equipment shall not be charged in excess of their rated capacity as designated by the manufacturer. The mixing times as hereinafter specified may be increased as ordered by the Engineer.

**Stationary  
mixers.**

When concrete is mixed in stationary mixers at the site of the work, the mixing time for each batch for mixers having capacities of one cubic yard or less shall not be less than the time required for 21 revolutions of the mixing drum and in no case less than 1½ minutes. For mixers of larger capacities, this minimum shall be increased 30 seconds or the time required for five revolutions of the mixing drum, whichever is the greater, for each cubic yard or fraction thereof of additional capacity. During this period the drum shall be in its mixing position and revolved at the mixing speed designated by the manufacturer of the equipment. Mixing time for each batch shall be measured from the time all cement and aggregates are in the drum. The batch shall be so charged into the mixer that some water will enter in advance of cement and aggregates and all water shall be in the drum by the end of the first one-fourth of the specified mixing time. Each mixer shall be equipped with an approved device to lock the discharge mechanism until the required mixing time has elapsed.

**Truck  
mixers.**

Truck mixers for mixing and transporting concrete shall only be used when authorized by the Engineer. When the concrete is mixed in a truck mixer, the number of revolutions of the drum or blades at the manufacturer's designated mixing speed shall not be less than 70 nor more than 100. All revolutions after 100 shall be at agitating speed as designated by

the manufacturer of the equipment. Only truck mixers equipped with accurate, operating revolution counters shall be used on the work. The final mixing operation shall begin within 30 minutes after the introduction of the cement to the aggregates. Water for truck mixing shall be weighed at the batching plant in accordance with the requirements of Section 14G.18 and shall be transported on the truck mixer in an approved, sealed tank separately from any wash or other water.

In case the concrete ingredients are batched at a point distant from the work, they shall be kept dry during transportation to the work. Cement shall be added at the site of the work unless otherwise approved by the Engineer. In any event, the complete mixing operation shall begin within 30 minutes after the introduction of the cement to the aggregates and the concrete shall reach its place of final deposit in not more than 75 minutes after the introduction of the cement to the aggregates. Dry batching.

When mixed concrete is transported in approved agitators or truck mixers, these shall be operated continually during the transit period at agitating speed and the concrete shall reach its place of final deposit in not more than 75 minutes after the introduction of the cement to the aggregates. Transportation of mixed concrete in non-agitating equipment may be authorized provided the equipment used and the method of transportation and handling are approved by the Engineer. Mixed concrete transported in approved non-agitating equipment shall reach its point of final deposit in not more than 30 minutes after the mixing water is introduced to the cement and aggregates. In hot weather or where there is evidence of segregation the transportation time of concrete may be reduced at the discretion of the Engineer. Transporting.

Any mixer, agitator, or non-agitating transporting equipment shall be checked, prior to its use on the work, by testing concrete of approved proportions, mixed or transported in such equipment, for uniformity as hereinafter specified. Slump tests, and air content tests for air-entrained concrete, shall be made on samples taken from the first and last one-tenth of a batch of mixed concrete. If these slumps differ by more than one inch or if the air contents, for air-entrained concrete, differ by more than 1½ percent, the equipment will not be approved for use until the condition causing the non-uniformity in the consistency or air content of the concrete is corrected. Use of the equipment may be permitted by the Engineer for operation with a longer mixing time or with a smaller load if such operation will result in meeting the requirements of the uniformity test. Mixers, agitators, and non-agitating transporting equipment used on the work shall be examined daily for accumulations of hardened concrete or mortar or for wear of the blades. If such conditions are disclosed, the uniformity test specified above shall be made and necessary corrective measures shall be taken. Hot weather.

Efficiency of mixers and transporting equipment in producing uniform concrete.



**Consistency.**

The quantity of water used shall be the minimum which will produce the consistency required by the conditions under which the concrete is to be placed. The water shall be accurately measured. The slumps shall be as ordered or approved within the limits of two to five inches. Mixtures that have an excessive water content shall not be used. All concrete when it goes into the forms shall be of uniform consistency without segregation, and shall not contain lumps. If at any time segregation occurs, the Engineer may require that the materials be satisfactorily remixed at the point of deposit.

**No retempering.**

No retempering will be allowed under any conditions, and all concrete which has its initial set before placing in the work shall be at once rejected and removed from the work.

**Preparing earth and rock surface for concreting.**

SECT. 14G.20 Earth surfaces against which concrete is to be placed shall be clean, damp, and free from frost, ice, and standing or running water and shall be compacted to the satisfaction of the Engineer. Rock surfaces against which concrete is to be placed shall be clean, free from oil, standing or running water, ice, mud, coatings, debris, and any loose, semidetached, or unsound material. Faults or seams shall be cleaned to a satisfactory depth and to firm rock on the sides. Immediately before the concrete is placed, all rock surfaces shall be cleaned thoroughly by the use of high velocity air-water jets or other approved methods. All rock surfaces shall be kept continuously wet for such period as directed immediately prior to placing the concrete. As directed, rock surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar of approved composition.

**Placing concrete.****Stiff concrete.****Protection of concrete from water.**

SECT. 14G.21 Concrete shall be deposited so as to maintain as nearly a level top surface as practicable in order to avoid segregation and shall be vibrated or spaded in a satisfactory manner. If a relatively stiff mixture be ordered, it shall be spread in layers about 18 inches thick, as directed. Puddling and vibrating shall be thorough for each layer. In general, the methods shall be such as to give a compact, dense, and impervious concrete. All devices necessary to produce a foundation free of running or standing water shall be installed and secured in place so as to prevent their being jarred loose during concreting operations. No concrete shall be placed against the surfaces of rock or concrete until all water entering the space to be filled with concrete has been cut off or has been diverted or taken care of by methods approved by the Engineer. No concrete shall be deposited under water without the explicit permission of the Engineer, and then only in strict accordance with his directions, nor shall the Contractor allow water to rise on any masonry until after it

has been in place for at least 24 hours unless specifically approved otherwise by the Engineer. Except as permitted in each case, concrete shall not be placed when the air temperature is below 45 degrees Fahrenheit nor if, at the time of placing, it is probable that the air temperature will fall to 32 degrees Fahrenheit or lower within the following 24 hours. In all such cases, permission will be given only when acceptable methods of heating the concrete materials and of maintaining a sufficient temperature and moisture content of the air in contact with such masonry have been submitted and approved. Concrete, when deposited in the forms during cold weather, shall have a temperature of not less than 45 degrees Fahrenheit nor more than 65 degrees Fahrenheit. Aggregates shall be so heated that frozen lumps, ice, and snow are eliminated. The use of steam jets for this purpose will not be permitted. Aggregates shall not be heated in excess of 125 degrees Fahrenheit. The temperature of all concrete placed during cold weather shall be maintained at 45 degrees Fahrenheit or warmer for a minimum of 72 hours. The maximum allowable gradual drop in temperature of the air in contact with the masonry in any 24-hour period following the 72-hour period shall not exceed 40 degrees Fahrenheit. The temperature of concrete as deposited in the forms in hot weather shall be kept as low as practicable and shall not exceed 85 degrees Fahrenheit. Any necessary control of the temperature of concrete shall be accomplished by approved methods.

Cold weather  
restrictions.

Hot weather  
restrictions.

SECT. 14G.22 For the proper bonding of fresh concrete with concrete which has set or partially set, such provision shall be made of steps, dovetails, or other devices as may be prescribed. Whenever fresh and old concrete masonry are joined, the contact surface of the old concrete shall be cleaned thoroughly by the use of high velocity air-water jets or other suitable methods. This cleaning shall be done immediately before the concrete is placed and shall remove all laitance, waste mortar, or other substances which would prevent complete adhesion. The surface shall be clean and wet but free from pools of water at the moment the fresh concrete is placed. Where ordered, a thick wash of rich mortar shall be brushed over the contact surface of the old concrete.

Building  
fresh con-  
crete on old.

SECT. 14G.23 Expansion, contraction, slip, or other special joints shall be formed wherever shown on the drawings or required. They shall be made by building smooth faces, acceptably coated with asphaltum paint or other approved substance, or separated by tar or asphalt saturated paper or fabric, as ordered, to prevent adhesion to the adjacent masonry and to permit expansion, contraction, or other movement. Such joints as directed, wherever watertight work is required, shall have approved water stops or

Contraction  
and other  
joints.



shall be grooved or otherwise shaped, caulked to the extent ordered with acceptable packing material, and filled with an acceptable, durable, water-proof, and elastic cement, or otherwise formed and treated to prevent leakage. Compensation for the work required by this section shall be considered as having been included in the prices stipulated for the several items of masonry in connection with which the joints are built, except that any ordered water stops or metal work forming a part thereof which is permanently built into the concrete, will be paid for under the appropriate items.

Placing reinforcement and setting metal work.

SECT. 14G.24 Portions of the concrete and other masonry, where shown on the drawings or ordered, shall contain steel bars or wire fabric for concrete reinforcement or structural steel to be furnished and placed under the appropriate items. There shall also be built into or set in or attached to the masonry, wherever directed, pipes, castings, metal frames, bolts, anchors, inserts, hangers, or other objects shown on the drawings, required by the specifications, or as ordered. Recesses, holes, or projections shall be left or made in the masonry, as ordered or approved, for metal work or other materials to be set under this or other contracts. All necessary precautions shall be taken when placing the concrete to prevent the reinforcement and other metal work or other materials above referred to from being displaced, broken, or deformed. Wherever watertightness is required, concrete, or brick work when specifically ordered or permitted, shall be so placed around the pipes or other metal work as to effectively prevent leakage and secure perfect adhesion. All metal work and other articles set under this contract shall be properly protected against injury and kept free from rust, mortar, or concrete.

Mortar and grout.

SECT. 14G.25 Mortar and grout shall be made of Portland cement, fine aggregate, and water of the qualities specified, mixed by hand or machine in such proportions and in such manner as directed, except that the cement mortar to be placed under Item 19 and the grout used for the work of Item 23 shall be as specified under those items. Mortar and grout shall be prepared in quantities such that they may be entirely used before they shall have attained their initial set.

Curing concrete masonry.

SECT. 14G.26 Every precaution shall be taken to prevent concrete and other masonry, wherever placed, from drying out until it has thoroughly set and hardened. To this end, sprinkling may be required to be begun as early as three hours after the placing of each section of masonry and thereafter all exposed concrete surfaces shall be kept continuously moist

for 14 days. The air in contact with masonry shall be kept at a temperature above 32 degrees Fahrenheit during the entire curing period. Wooden forms shall be wetted immediately before masonry is placed and shall be kept wet until removed.

SECT. 14G.27 The construction of masonry may be prohibited at any time when, in the judgment of the Engineer, the conditions are unsuitable or the proper precautions are not being taken, or the work is being conducted in any way unsatisfactory to the Engineer. In all heavy sections of concrete, both the total volume and the rate of placing shall be regulated and controlled so as to avoid unduly high temperatures during the period while the cement is setting and hardening. All procedures in these matters shall be subject to the prior approval of the Engineer.

Masonry construction may be stopped when conditions are unsuitable.

SECT. 14G.28 Any masonry which shall be found defective at any time before the completion of this contract shall be cut out to the extent ordered and replaced without additional payment therefor. Local repairs shall be made only if explicitly permitted and, if so ordered, they shall be made immediately on removal of the forms. No thin patches or plastering on concrete masonry will be permitted, but recesses shall be cut of a shape to retain the patches and of a depth to insure their permanency. If required, anchor bolts shall be set in drilled holes, and these and wire mesh or other suitable devices embedded in the patch. No mortar richer than one part of cement to  $1\frac{1}{2}$  parts of sand shall be used in repairs. Concrete or other masonry that develops any defects from freezing or lack of moisture, or from any other cause for which the Contractor is responsible, shall be satisfactorily repaired or replaced at the expense of the Contractor.

Defective masonry.

SECT. 14G.29 All stones for stone masonry shall be handled carefully so as not to mar the exposed faces. The erection of machinery or of centering and forms, or the landing and storing of stones or other heavy objects upon the surfaces of masonry under construction, or walking or working on them, will not be permitted until an acceptable time has elapsed for the setting of the concrete or mortar of the masonry. Wherever ordered, the Contractor shall provide, at his own expense, timber coverings for the protection of fresh masonry and platforms for landing and storing stones, buckets, and other heavy objects. These coverings and platforms shall have no supports on the masonry except where permitted. Care shall be exercised to avoid disturbing in any way the stones used for facings and copings after they have been set, unless particular stones

Protection of masonry under construction.



shall be ordered removed. Whenever a stone that has been set has its bond broken, it shall be taken up and reset.

Protecting  
exposed  
faces.

SECT. 14G.30 The exposed faces of all masonry which is to be permanently exposed to view shall be effectively protected from injury or disfigurement by the falling of tools, mortar, or other objects until the final acceptance of the work. The Contractor shall build, at his own expense, timber or other acceptable coverings over the masonry, if necessary, for proper protection in the vicinity of landing platforms, under derricks and in any other places where the faces are particularly liable to injury.

Removing and  
replacing  
masonry.

SECT. 14G.31 If, in accordance with Article XIII, the Contractor removes as directed, portions of the masonry, and the work thus exposed for examination and the masonry so removed are found satisfactory, or if for any other reason he shall be ordered to remove masonry built in full accordance with this contract, the removal shall be paid for under Item 4 and the replacement as well as the original masonry shall be included under the appropriate items. In connection with the removing and replacing of masonry in accordance with this section, no quantity shall be measured as less than one cubic yard.

Test speci-  
mens of  
masonry.

SECT. 14G.32 As required for test purposes, the Contractor shall make, care for, and store cylinders, cubes, beams, slabs, or other shapes of concrete masonry and shall furnish the Engineer with small quantities of mortar or concrete, and shall receive therefor the price stipulated under the appropriate items for the quantities as actually furnished in accordance with directions.

#### FINISHING CONCRETE SURFACES

Finish and  
protection  
of concrete.

SECT. 14G.33 Small projections on concrete surfaces and minor unevennesses at the junction of forms and elsewhere, which are not serious enough to require the repairs stipulated in Section 14G.28, shall be removed or acceptably corrected by skilled men upon removal of the forms. Concrete that is not placed against forms shall be screeded to the required lines and grades and floated by skilled artisans to a smooth, even surface. Such care shall be taken as shall effectively prevent the formation of depressions from which water will not drain. Where waterproofing is to be applied to concrete, the surface shall be left in a satisfactory condition for its application. Steel troweling shall be done where shown

on the drawings or ordered. For the top finish of walls and similar structures, the forms shall be overfilled with from one to  $1\frac{1}{2}$  inches of concrete. This excess concrete shall then be screeded off just before the initial set begins, as indicated by the apparent drying up of the surface, and worked to the completed and not too slick surface with a minimum of floating and troweling. At no time in the process of finishing any concrete surface shall it be dusted with dry Portland cement or any other material. Exposed surfaces which are not brought to an approved finish as above provided shall, as directed, be rubbed to an acceptably smooth condition with a carborundum brick or finished by other approved methods. In general, all such finishing shall be done in the dry, the purpose being to remove roughness and not to produce a slick surface. Finished masonry surfaces shall be protected carefully from all injury and left in satisfactory condition at the completion of the work.

SECT. 14G.34 Granolithic finish of the thickness and to the extent shown on the drawings or ordered, shall be applied to concrete floors and other concrete surfaces, not more than one hour after placing the base, unless otherwise ordered or permitted. Where shown on the drawings or ordered, the granolithic finish shall include the forming of a sanitary cove base at walls and partitions. Granolithic finish shall be mixed in the proportions directed. Unless otherwise ordered, the proportions shall be one part cement, one part fine aggregate, and two parts coarse aggregate by volume with  $4\frac{1}{4}$  gallons of water per bag of cement for machine floating or  $3\frac{1}{4}$  gallons of water per bag of cement for hand floating. Cement shall be of the quality specified in Item 24. Fine aggregate shall be sand in accordance with Section 14G.5, free from dust, clay, loam, or vegetable matter, passing a  $1/4$ -inch mesh sieve, graded from fine to coarse with the coarse predominating. Coarse aggregate shall be clean fragments of traprock or granite, free from dust, clay, loam, vegetable matter, and other coatings, passing a  $3/8$ -inch mesh sieve, graded from  $1/8$  inch to  $3/8$  inch. Water shall be in accordance with Section 14G.12. The time of mixing each batch after all the ingredients are in the mixer shall be two minutes. After screeding, the granolithic finish shall be compacted by rolling or tamping and floated with a wooden float or floating machine. Steel troweling, where ordered, shall be done 30 to 45 minutes after the floating, when the finish has hardened sufficiently and there is no surface water left; a smooth surface shall be produced with the minimum of troweling. All granolithic finish shall be equal to the best sidewalk surfacing and shall be done by a skilled concrete finisher. Finished surfaces shall be divided by contraction joints and intermediate scoring, as indicated on the drawings or ordered. Granolithic finish that is not true to line and grade or that develops cracks or other defects shall be repaired or replaced, as provided in Section 14G.28.

Granolithic  
finish.



Cleaning  
exposed  
surfaces.

SECT. 14G.35 The Contractor shall carefully clean all exposed surfaces of masonry work at the time designated prior to the final acceptance of the work. No direct payment shall be made for such cleaning, but compensation therefor shall be considered as having been included in the prices stipulated for the appropriate items.

#### BRICKS AND CONCRETE BLOCKS

Laying  
concrete  
blocks.

SECT. 14G.36 The first course of concrete blocks shall be laid in a full mortar bed spread and furrowed on top of an acceptable footing. All other joints shall be formed by applying mortar to the web and face shells of the blocks and firmly setting each block in place. All concrete block masonry shall be laid plumb, true to line, and with level and accurately spaced courses. Vertical joints shall break halfway over units in the course next below. Sufficient mortar shall be used to insure well filled joints, approximately  $\frac{3}{8}$  inch wide, and all necessary adjustments of the units shall be made while the mortar is still plastic. Metal anchors and inserts shall be placed in an approved manner as the masonry work progresses. The top course of each wall shall have the hollow cores filled with concrete or mortar.

Laying  
bricks.

SECT. 14G.37 Bricks shall be laid in Portland cement mortar. Each brick shall be wet thoroughly just before being laid by immersion for a sufficient time to fill its pores with water and, after draining off the surplus water, it shall be embedded in mortar at the bottom, sides, and ends at one operation, care being taken to fill every joint, and the work shall be well and thoroughly bonded. Bricks shall be laid to the lines indicated, with joints as directed, but in general not less than  $\frac{1}{4}$  inch. The outside surfaces of brick work for manholes shall be plastered with cement mortar  $\frac{1}{2}$  inch thick.

#### PAYMENT

Payment  
under items  
only.

SECT. 14G.38 Except for other materials substituted for concrete masonry, as stipulated in Section 14G.1, notwithstanding any statement or implication to the contrary in any of the foregoing Sections 14G.1 to 14G.37, both inclusive, no payment will be made for any of the work or materials or operations therein mentioned and described other than as provided in the payment clauses of the various items of these specifications.

## CONCRETE MASONRY

## ITEM 14

SECT. 14.1 Under Item 14 the Contractor shall furnish all labor, equipment including forms, and materials, except cement, and shall place all concrete masonry for the waste weir, the waste channel sills, the gaging weir, the emergency gate tower and the bridge to the tower, the plugging of the diversion conduit and the temporary release water pipe, the lining and envelope of the release water conduit, the release water chamber, retaining walls, footings and foundations, piers, manholes, catch basins, drains, stop logs, settlement measurement plates, posts, and culverts and for other contract purposes, as shown on the drawings or ordered. This item does not include concrete masonry included in the work to be done under other items. The use of concrete block masonry under this item for the foundation of any ordered chlorinator house is permitted. As a part of the work under this item, the Contractor shall furnish an air-entraining admixture and add it to the concrete where such masonry, in the opinion of the Engineer, will be exposed to frost action; apply a granolithic finish to the floors and adjacent sanitary cove bases in the release water chamber; rub smooth with carbonrundum stone designated concrete surfaces; waterproof the roof and portions of the walls of the release water chamber, place a parging coat of cement mortar plaster on portions of the walls of the release water chamber; and furnish and place premoulded and elastic joint filler and lubricating coating compound, all as specified and to the extent shown on the drawings or ordered. The concrete masonry placed under this item will generally be reinforced with steel furnished and placed under Item 30. Certain portions of the concrete masonry may contain structural steel, anchoring devices, water stops, piping, conduits, or other materials furnished and placed under other appropriate items of the contract.

Work  
included.

SECT. 14.2 The water, cement, air-entraining admixture, and coarse and fine aggregates, the mixing and placing of concrete, the construction of joints, the placing of reinforcement and other metal work, the finishing and cleaning of exposed surfaces, the protection and curing of the concrete, and the replacement and maintenance of the masonry shall conform to the requirements of Sections 14G.1 to 14G.37, inclusive, in so far as they are applicable. The concrete masonry for the waste weir and elsewhere shall be placed in blocks, sections, or lifts as shown on the drawings or ordered and, unless otherwise approved, there shall be a minimum interval of three days between the placing of adjacent blocks, sections, or lifts. For concrete that is reinforced, the coarse aggregate shall be of

Materials  
and placing.



such size as will work closely around the reinforcing metal, leaving no voids. Concrete shall be placed continuously within the limits shown on the drawings or ordered, so as not to impair the strength of any structure or member. The concrete envelope surrounding the release water conduit shall be placed while the conduit is under a hydrostatic pressure of 80 pounds per square inch. This pressure shall be maintained for at least two days after any section of such concrete has been placed. The concrete lining of the release water conduit shall be placed by approved methods after the concrete envelope has been completed. Particular care shall be exercised in placing the concrete lining of the venturi meter enlargement and the manifold of the release water conduit in order to obtain specially smooth and true waterway surfaces.

**Forms.**

SECT. 14.3 The Contractor shall provide all necessary forms, moulds, and screeds for shaping the concrete, and the construction, use, and removal of such forms, moulds, and screeds shall comply with the requirements of Sections 14G.13 to 14G.15, inclusive. Except as otherwise approved, steel or steel faced forms and screeds shall be used for the waterway of the lining of the release water conduit. If the subgrade of any concrete structure should be such as to require the use of wooden platforms at any place, such platforms shall be furnished and placed under Item 12. For all expenses connected with providing, erecting, maintaining, and removing the forms and finally disposing of them, the Contractor shall receive no direct compensation, but the cost thereof shall be considered as having been included in the price stipulated for this item.

**Removable  
slabs and  
beams.**

SECT. 14.4 Portions of the roof of the release water chamber, the top of the emergency gate tower, and other structures if required, shall be made in the form of removable slabs, beams, panels, or frames, strengthened with reinforcing or structural steel, or both, edged with metal work as shown on the drawings or ordered, and cast in place on the seats on which they are finally to rest. Where ordered, joints about the removable slabs shall be acceptably packed and filled with elastic cement, as provided in Section 14G.23. Cast iron thimbles, metal edgings, lifting devices, and other metal work, also lifting holes, matchmarks, and identifying numbers, shall be set, cast, or moulded, as shown on the drawings or ordered.

**Joint  
fillers.**

SECT. 14.5 Approved premoulded joint filler and elastic joint filler and sealer, as shown on the drawings or ordered, shall be furnished and placed under this item.

SECT. 14.6 The roof and portions of the outside faces of the walls of the release water chamber shall be waterproofed with four layers of tarred felt waterproofing acceptably laid in coal-tar pitch. When the roof of the release water chamber is completed and the joints in the removable slabs packed and cemented, the surface of the roof shall be made thoroughly clean and dry and then waterproofed. Laps in each layer of tarred felt waterproofing shall be 17 inches and all surfaces of felt shall be thoroughly covered with tar. The felt used shall be coal-tar saturated felt, 32 inches in width, which shall comply in all respects with the Standard Specifications for Coal-Tar Saturated Roofing Felt for Use in Waterproofing and in Constructing Built-Up Roofs, ASTM Designation: D227-56, of the American Society for Testing Materials. The coal-tar pitch used shall comply in all respects with the Standard Specifications for Coal-Tar Pitch for Roofing, Dampproofing, and Waterproofing, ASTM Designation: D450-41, Type B, of the American Society for Testing Materials, and not less than 200 pounds of pitch shall be used for each 100 square feet of roof. The pitch shall not be heated above 400 degrees Fahrenheit and shall be applied when hot. Each roll of felt and each barrel of pitch shall bear the manufacturer's label and the Underwriters' Laboratory label certifying the material to be approved for Class "A" roofing.

Waterproofing  
of release  
water chamber.

The waterproofing on the walls of the release water chamber shall be protected with a parging coat of cement mortar plaster as shown on the drawings. The parging shall be estimated for payment under this item.

Parging.

SECT. 14.7 The quantity of concrete masonry, including granolithic finish and parging coat of cement mortar plaster, to be paid for under Item 14 shall be the number of cubic yards, measured in final position, that are placed within ordered or approved limits. For structures built against the surfaces of rock excavations, the payment lines for rock excavation shall be the payment lines for this item. Concrete masonry and mortar used in connection with the placing of stone facing and rubble masonry and paving shall not be included for payment under this item. No deduction shall be made for any embedded metal work or other solid material, any opening or pipe with a cross-sectional area of less than one square foot, nor for any ordered space, void, groove, or recess of 1/2 cubic yard or less. Small quantities of rubble or brick masonry, including mortar or grout, that are used by permission for convenience in setting pipes, in manholes, in temporary walls, or for other purposes in connection with concrete masonry shall be measured and paid for under Item 14. Concrete block masonry for the foundation of any ordered chlorinator house shall be measured for payment under Item 14 but no payment shall be made for the cement used in manufacturing nor for the cement mortar required for placing these

Measurement  
and  
payment.



blocks. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. No separate payment will be made for furnishing and adding an air-entraining admixture, for rubbing concrete surfaces with carborundum stone, for furnishing and placing joint fillers and sealers, or for waterproofing portions of the release water chamber, but the cost thereof shall be considered as included in the price stipulated for Item 14. No direct payment shall be made for concrete masonry placed outside of the ordered or approved limits, nor for concrete required to fill unauthorized excavations, nor for the cement therein, but the cost thereof shall be considered as having been included in the prices stipulated for the various items. Portland cement used for the concrete masonry included for payment under this item will be paid for under Item 24; and, to the extent that such materials are actually incorporated in the work in accordance with orders, rubber water stops, reinforcing and structural steel, and other metal work will be paid for under the appropriate items.

DRY RUBBLE MASONRY AND PAVING, RUBBLE MASONRY  
AND PAVING IN MORTAR, AND STONE FACING

ITEMS 15, 16, AND 17

Work  
included.

SECT. 15.1 Under Item 15 the Contractor shall furnish and place dry rubble masonry and paving for walls, for paving around catch basins, for paving the east and west plazas at the ends of the waste weir, for paving near the west end of the high weir, for drainage gutters, and for other purposes as shown on the drawings or ordered, together with all ordered sand and crushed stone or gravel used as bedding or to fill joints in the paving. Under Item 16 the Contractor shall furnish and place rubble masonry and paving in mortar for walls, for paving over the 30-inch pipe in the waste channel, for paving the berm north of the west plaza, for paving at the ends of the gaging weir, for drainage gutters, and for other purposes as shown on the drawings or ordered, together with ordered concrete bases and mortar or grout required to thoroughly fill all joints. Under Item 17 the Contractor shall furnish and place stone facing for facing the low weir, for facing a portion of the south wall of the weir channel and the easterly end of the south wall of the waste channel, for facing retaining and wing walls, for the parapet wall at the west plaza, and for other purposes as shown on the drawings or ordered, together with any concrete or other masonry backing specified to be furnished under this item. Drains shall be placed as provided in Section 15.4. Pipes ordered for drains will be paid for under Item 29.

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SECT. 15.2 Stones for masonry, paving, and facing, and sand and crushed stone or gravel shall be of the qualities specified in Sections 14G.10, 14G.5, and 14G.6, respectively. The mortar and grout shall be as specified in Section 14G.25 and the proportion of sand shall be as directed from time to time. The provisions of Sections 14G.1, to 14G.38, inclusive, in so far as they are applicable, shall apply to these items. Stone from the required excavations will not be acceptable for stone facing. The general color and texture of the stone for rubble masonry and stone facing shall be as ordered or approved. Samples of the stone proposed to be used for stone facing shall be furnished to the Engineer for his approval.

Quality of  
materials  
and  
workmanship.

SECT. 15.3 Rubble masonry, rubble paving, and stone facing shall be built of stones of suitable size for the work in hand, having such minimum dimensions in each case as are shown on the drawings, specified, ordered, or approved. The exposed faces of stones in rubble masonry and paving shall be approximately flat. Stones for stone facing shall be roughly squared so as to present approximately flat rectangular faces of the required finish and shall have sides sufficiently straight to provide joints of the thickness specified. Facing stones shall be laid so as to break joints as directed and with reeding planes normal to the exposed faces. At least one-fourth of the stones in any face of a rubble masonry structure shall be headers evenly distributed throughout the surface and extending into the structure to such depth as required. For paving, very few stones shall have a depth less than two-thirds that of the paving and at least one-third of them shall be full depth and evenly distributed. For stone facing, the depth of stones shall be as shown on the drawings. Stones used in facing and paving shall be placed with the longest dimension of the exposed face normal to the slope of the surface.

Size and  
placing of  
stones.

SECT. 15.4 Drains of vitrified or approved alternate pipe shall be constructed behind stone facing and shall be surrounded with coarse, uniform crushed stone or gravel, as shown on the drawings. Vitrified pipe drains shall be laid with open joints and every fourth length shall be perforated. Bituminized-fibre or asbestos-cement pipe approved as an alternate for vitrified pipe shall be perforated as required. Acceptable methods shall be adopted to prevent clogging of the pipes, crushed stone, or gravel with grout or mortar.

Drains.

SECT. 15.5 Dry rubble masonry shall be built of stones of sizes and shapes as directed. No stone shall be less than six inches in thickness, and no stone shall measure in its least horizontal dimension less than

Dry rubble  
masonry.



12 inches nor less than its thickness. All spaces between stones shall be solidly packed with spalls. Selected stones, neatly pitched to line, shall be used at all angles and face stones shall be roughly squared so as to present approximately flat faces. Walls shall be coped with stones of the thicknesses ordered, extending entirely across their tops, with neatly squared edges, and laid with close joints.

Dry rubble  
paving.

SECT. 15.6 Dry rubble paving shall be built of stones with even top faces having an area, unless otherwise permitted, of not less than two square feet. Paving stones shall be placed in contact with each other, thoroughly bedded in crushed stone or gravel. Joints shall be thoroughly filled with tightly driven spalls to secure a solid construction with a firm, true water face. Dry rubble paving for gutters and other minor structures, as ordered, shall be built of stones of ordered sizes laid on edge, true to line and grade, bedded in sufficient sand to bring them to a uniform surface, thoroughly rammed in place, and all joints swept full of sand.

Rubble  
masonry  
in mortar.

SECT. 15.7 Rubble masonry in mortar shall be built of stones not less than eight inches by 16 inches by 16 inches, laid to break joints at least four inches. Each stone shall be placed in a bed of mortar and settled to a full bearing and vertical joints shall be filled with mortar thoroughly rodded. No spalls shall be used which in any way interfere with the placing of mortar. The requirements of Section 15.5 regarding selected stones, face stones, and copings shall be complied with as ordered.

Rubble  
paving in  
mortar.

SECT. 15.8 Rubble paving in mortar shall be built of stones with even top faces having an area, unless otherwise permitted, of not less than two square feet. Paving stones shall be laid close together and supported on spalls or broken stone so that their top faces will form an even surface at the required slope having joints not exceeding three inches at the surface. Voids beneath and between the lower ends of the stones shall be packed tightly with clean broken stone of sufficient coarseness to permit penetration of grout. An occasional course across the area being paved shall be laid in mortar to form a stop, permitting grouting to be completed in sections. All joints shall be poured full, using a creamy grout mixed in ordered proportions. Paving may be laid on a mortar or concrete bed and mortar may be used in the joints, provided acceptable methods are adopted to completely fill all voids with spalls and mortar immediately after the paving is laid to insure monolithic construction throughout. Mortar or grout shall be broomed into the joints of the paving and all excess mortar or

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grout shall be removed from the top of the paving by washing or other approved means. Light rubble paving in mortar for gutters and elsewhere as ordered shall be built of stones of acceptable sizes, bedded in a 6-inch foundation of concrete, if required, and laid as herein specified.

SECT. 15.9 Stone facing for excavated rock slopes shall be built of stones with exposed faces not less than 12 inches by 24 inches, unless otherwise permitted. The stones shall have a rock face or split face finish with no projections more than three inches beyond the pitch line, except as otherwise shown on the drawings. No drill holes shall show in the finished stone facing. The coursing of the stone facing shall be broken range or random range, as approved. Facing stones shall be laid carefully to line, with face joints averaging about one inch and nowhere greater than two inches in thickness, in full mortar beds, with vertical joints thoroughly filled with spalls and mortar and spaces between the facing stones and the ledge rock filled with concrete, mortar, or stone masonry in mortar as directed. Joints shall be pointed with a smooth tool before the mortar is set hard, the purpose being to have the joint-filling mortar monolithic and to require no raking out and separate pointing. The surfaces of joints shall be struck off neatly to the pitch lines and the faces of stones shall be left clean and free from mortar. Granite coping for stone facing, as shown on the drawings, shall be furnished and placed under Item 18 and shall comply with the applicable requirements of that item.

Stone facing  
for  
excavated  
rock surfaces

**REVISED**  
SEE ADDENDUM

SECT. 15.10 The applicable provisions of Section 15.9 shall apply to stone facing for the low weir, concrete retaining walls, and other structures as ordered. Stone facing for the low weir and its end walls shall be built of stones with finishes as shown on the drawings. Sheet 32 of the contract drawings shows the portion of the low weir in which the faces of the stones shall have no projection more than 1/4 inch and Sheets 32, 34, and 35 show the portions of the low weir and of the walls at the end of the low weir in which the faces of the stones shall have no projections more than one inch. The face joints shall not exceed one inch in width and adjacent stones shall be laid with the edges flush. Continuous vertical contraction joints, 3/4 inch wide and spaced as shown on the drawings, shall be built, as directed, using stones which have been neatly pitched to line. The stone facing shall be placed monolithically with the concrete, or as approved by the Engineer, shall be well bonded thereto by heavy metal anchors and dowels. For monolithic construction, the stone facing shall be placed in advance of the concrete masonry to serve as a form but shall not be built in greater lifts than are authorized. Metal anchors and

Stone facing  
for the low  
weir and  
concrete  
structures.

**REVISED**  
SEE ADDENDUM



dowels that are required because the stone facing is not placed monolithically with the concrete shall be furnished and placed under Item 17. Prior to placing any concrete for the portions of structures which are to be faced with stone, the Contractor shall submit for approval complete and detailed drawings and procedure for placing the stone facing and anchoring it to the concrete masonry.

**Measurement  
and payment.**

SECT. 15.11 The quantities to be paid for under Items 15, 16, and 17 shall be the number of cubic yards, respectively, of dry rubble masonry and paving, rubble masonry and paving in mortar, and stone facing, furnished and placed in accordance with orders within the limits prescribed, without deduction for drains. For purposes of measurement, the exposed faces of structures under these items shall be assumed to be planes through the ordered location of pitch lines at the faces. The thickness of rubble masonry and paving and of stone facing shall be as shown on the drawings or ordered for each location. For rubble masonry or paving or stone facing built against the surfaces of rock excavations, the payment lines for rock excavations shall be the payment lines for these items, and no payment will be made for concrete or other masonry, or the cement therein, required to fill unauthorized excavations outside these limits. For stone facing for concrete structures, the payment line shall be the division line between Items 14 and 17, as shown on the drawings. Joints between granite coping and stone facing shall be included for payment under Item 17. No payment under their respective items will be made for concrete, sand, crushed stone or gravel, mortar, and grout used within the prescribed limits of the masonry, paving, and facing of Items 15, 16, and 17, for backing or bedding or to fill joints, their volumes having been included in the measurement for payment for Items 15, 16, and 17, as appropriate. If dry rubble masonry or paving is grouted in accordance with orders, it shall be measured for payment as rubble masonry or paving in mortar. The prices per cubic yard stipulated for these items shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under these items, in the manner herein set forth and specified. Vitrified or other approved alternate pipes used in the construction of drains will be included for payment under Item 29, but the cost of furnishing and placing coarse, uniform crushed stone or gravel and all other costs in connection with the construction of drains shall be considered as included in the price stipulated for Item 15, 16, or 17, as appropriate. Cement, anchors, dowels, and drilling holes in rock or masonry, will be paid for under the appropriate items. However, no separate payment will be made for furnishing and placing metal anchors and dowels specified in Section 15.10, but the cost thereof shall be considered as included in the price stipulated for Item 17.

## GRANITE MASONRY

## ITEM 18

SECT. 18.1 Under Item 18 the Contractor shall furnish all materials, except dowels, anchors, and other metal work, and cement, and shall set in place all granite masonry for coping the stone facing placed under Item 17, for the crest and toe stones of the low weir, for the facing and trim of exposed portions of the release water chamber, the emergency gate tower, and the walls of the west abutment of the bridge to the emergency gate tower, and for other purposes, as shown on the drawings or ordered. As a part of the work under this item, the Contractor shall do such trimming, drilling, cutting, and dressing as may be ordered or approved. All materials and workmanship in connection with the setting of the granite masonry shall comply with the requirements of Sections 14G.1 to 14G.38, inclusive, in so far as they are applicable. The furnishing and placing of approved stainless elastic expansion joint compound, prefabricated joint filler, and mastic, as required, shall be included in this item.

Work  
included.

SECT. 18.2 The granite shall be of approved color, shall be selected to meet the requirements of these specifications, and shall be strong and durable, of uniform, medium to coarse grained texture, with an even distribution of constituent minerals, practically nonabsorbent, and free from discoloration or evidence of decay and from foreign inclusions and all other defects which would impair its strength or mar its appearance. It shall be a granite equal in its general color, tone, and texture to the Deer Island granite quarried and cut at Crotch Island, Stonington, Maine, by the Deer Island Granite Corporation, or to the Mount Waldo granite quarried and cut at Frankfort, Maine, by Grenci and Ellis, Incorporated, or to the Chelmsford, Massachusetts granite quarried and cut by the H. E. Fletcher Company, at West Chelmsford, Massachusetts.

Quality of  
granite.

SECT. 18.3 The granite shall be obtained from approved quarries producing stone of the quality specified, which has been demonstrated by exposure in structures to be resistant to weathering. The quarrying, cutting, and finishing shall be done by approved firms having adequate facilities to produce finished granite as herein specified without causing delay to the work.

Quarries  
and plant.

SECT. 18.4 The Contractor shall submit for approval the name and location of the quarry and shop from which he proposes to furnish the granite and, if ordered, he shall provide as many duplicate samples, about

Samples and  
drawings.

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eight inches by eight inches by two inches, as are required to show the extreme variations in quality, color, and texture of the granite he proposes to furnish and each kind of finish shown on the drawings or ordered. The Contractor shall prepare and submit for approval all necessary shop and erection drawings showing the dimensions, profile, setting number, bedding, jointing, bonding, and anchorage of each piece of granite. All granite work shall conform strictly to the approved samples and drawings, unless otherwise ordered.

**Finishes.**

SECT. 18.5 All exposed surfaces of the granite furnished under this item shall have the finishes shown on the drawings or specified, with no part of the surfaces below the pitch lines; and all finishes shall be equal to the approved samples. Arris lines shall be straight, with no nicks or depressions exceeding 1/16 inch. The granite for the crest and toe stones of the low weir shall be cut and dressed to the dimensions shown on the drawings. Granite coping for stone facing shall have a rock face finish, with no projections more than one inch above the pitch lines, except where otherwise shown on the drawings. Hand tooling necessary to give the stones the required finish may be required.

**Cutting  
stones; beds  
and joints.**

SECT. 18.6 All exposed surfaces of granite masonry shall be out-of-wind, free from waves, projections, or depressions except as allowed or required for a particular finish. The faces of all stones in the same plane and the lines of adjoining arrises shall be continuous and flush at the joints. No patching or concealment of defects will be permitted. Stones shall be laid with their reeding or cleavage planes normal to the exposed faces. Except as otherwise shown on the drawings, beds and joints shall be sawed or cut full and square two inches back from the face, and from that point they may fall under the square not in excess of one inch in 12 inches. As shown on the drawings, certain beds and joints shall be cut full and square for at least four inches or at least six inches back from the face. The backs of stones shall be scabbled or split to surfaces which shall not vary more than one inch in 12 inches nor more than three inches either way from the dimension lines shown on the drawings. Except as otherwise ordered, joints between granite facing stones shall be 3/8 inch wide; those between coping stones shall be 3/4 inch wide; and those between the crest stones and between the toe stones shall be 1/2 inch wide. Coping stones for stone facing shall be of random lengths, from three to nine feet long, with joints offset from those in the stone work immediately below. Stones for facing, the toe stones for the low weir, and coping stones shall be drilled for dowels or drilled, recessed, rabbetted, or provided with

sinkages, for anchors, as required and as shown on the approved shop drawings. Granite work shall be provided with contraction or expansion joints as shown on the drawings or ordered, with beds or joints dressed throughout.

Contraction joints.

SECT. 18.7 The finished stones will receive a preliminary inspection at the quarry or shop before shipment to the work and, if found unsatisfactory, shall be promptly replaced. After such inspection, the stones shall be carefully protected from injury and so packed for transportation and handled as to avoid marring the edges, surfaces, and portions to be exposed in the structures. Any stone marred during its moving at the storage site or elsewhere, or in transportation or before or after installation and before final acceptance in the structures, shall be promptly replaced at the expense of the Contractor. No packing materials that will stain or discolor the stones shall be used. During freezing weather all lewis and other holes in the stones, as soon as the stone is fabricated, shall be filled and kept full of nonstaining and waterproof material. Prior to installation in the work, any stone that does not meet the requirements of Section 18.2 will be rejected.

Inspection and shipment of granite.

SECT. 18.8 All stones shall be cleaned and wetted to the extent directed, immediately before setting, and each stone shall be lowered carefully into properly prepared full beds of mortar, as required, and tapped home to a full and solid bearing; the voids between the backs of stones and other masonry shall be filled with a dense plastic mortar, as required, during this operation and the stones accurately set to true and level lines. No stone work shall be laid when the temperature is below 45 degrees Fahrenheit or when it is probable that the air temperature will fall to 32 degrees Fahrenheit or lower within 24 hours. Attention is directed to the accuracy required and magnitude of the work involved in placing the crest and toe stones of the low weir, especially in forming their foundation, bedding, wedging, anchoring, and grouting. The beds and joints of these stones shall be placed with special care to assure watertightness, and grouting with dense plastic mortar under pressure to an extent and in a manner as approved by the Engineer may be required. These stones shall be carefully and accurately set in place with variations from true alignment and profile not to exceed 1/4 inch and the difference in the adjoining surfaces shall be dressed as required. All joints shall be completely filled with dense mortar, carefully worked in and finished as the work progresses except where joints are to be left recessed and pointed later. Vertical joints between crest stones and between toe stones of the low weir and

Setting, pointing, and cleaning.

Grouting of joints.

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Projecting  
stone work  
to be pro-  
tected.

Cleaning.

elsewhere, if ordered, shall be caulked with oakum to a depth of two inches and these joints filled with mortar and thoroughly rodded. After the mortar is set the oakum shall be removed and the joints acceptably wetted and pointed. The face of all granite work shall be kept free from mortar. As the setting of the granite proceeds, all projecting stone work that is liable to become damaged shall be protected with satisfactory nonstaining boards or boxing put together with galvanized nails to avoid rust staining the stones. On completion of all masonry work of any structure, the granite shall be carefully cleaned with the other stone masonry work, using soap powder, boiled in clean water and applied vigorously with stiff fiber brushes. No wire brushes or acids shall be used. Clean, sharp sand may be used where permitted by the Engineer.

Anchors and  
dowels.

SECT. 18.9 The granite facing of the release water chamber, the emergency gate tower, the walls of the west abutment of the bridge to the emergency gate tower, and elsewhere as ordered, shall be anchored to the concrete masonry by galvanized steel anchors not less than 3/16-inch thick and one-inch wide, turned down to engage holes in the granite stones for a depth of not less than one inch. These anchors shall extend into the concrete masonry not less than six inches or shall engage and be cemented into approved galvanized steel inserts in the concrete, giving equivalent anchorage. In general, there shall be not less than two anchors to every square yard of exposed granite masonry. Dowels, anchors, cramps, and other fastening devices shall be used as shown on the drawings or as approved. Anchors and dowels of reinforcing steel shall comply with the requirements of Item 30. Galvanized steel anchors, dowels, and cramps shall comply with the requirements of Item 37 in so far as they are applicable.

Mortar.

SECT. 18.10 Mortar for laying granite shall, in general and unless otherwise directed, consist of one part of Portland cement and two parts of fine aggregate by volume. The fine aggregate shall be such as to cause no staining of the stones or harmful chemical reaction with the cement. The mortar shall be mixed dry, in small batches, to which clean, fresh water shall be added and the whole remixed until thoroughly homogeneous. The mortar shall not be retempered after it has begun to set.

Measurement  
and payment.

SECT. 18.11 The quantity to be paid for under Item 18 shall be the number of cubic yards of granite masonry placed in the work in accordance with the drawings or orders, measured as stipulated below. Granite coping shall be measured in place without deductions for mortar joints between

adjacent granite stones or for embedded metal work. The granite masonry in the low weir crest shall be measured as having a cross-sectional area of 13.34 square feet and a length of 245 feet. The average cross-sectional area of the granite crest stones for the low weir, as actually furnished and placed, shall not be less than 13.34 square feet. For other locations, the granite shall be measured in place without deductions for open or mortar joints between adjacent granite stones or for embedded metal work, subject to the provision that no stone shall be estimated for payment as having a thickness greater than shown on the drawings or ordered. The exposed faces of the granite shall be assumed to be the surfaces defined by the draft or pitch lines, or the finished profiles of the smoothly dressed stones. On surfaces other than exposed faces, measurement shall be to the dimension lines shown on the approved shop and erection drawings without additions or deductions for allowable tolerances. Mortar joints between the granite placed under this item and other masonry will not be paid for under this item but will be included for payment under the item for such other masonry. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. To the extent that such materials are incorporated in the work in accordance with orders, anchors, dowels, and other metal work and cement will be paid for under the appropriate items, but no separate payment will be made for mortar. No direct payment will be made for packing the granite, boxing it in place, for cutting or for drilling holes for anchors, dowels, or other metal work or other work required to complete the granite masonry nor for forms, centers, bracing, scaffolding, joint compound, and joint filler, the cost thereof being considered as having been included in the price stipulated for this item.

#### PROTECTIVE COATINGS OF CEMENT MORTAR

##### ITEM 19

SECT. 19.1 Under Item 19 the Contractor shall place, cure, and maintain pneumatically applied protective coatings of cement mortar on portions of the exposed rock surfaces of the weir approach channel, the weir and waste channels, and other rock excavations, where ordered, to prevent them from drying, cracking, spalling, or disintegrating or where, in the opinion of the Engineer, exposure to the air may make these surfaces unsafe or unstable. As a part of the work under this item, the Contractor shall clean and prepare all rock surfaces which are to receive coatings of cement mortar, and shall caulk seams in the rock where required. As re-

Work  
included.

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quired, weep pipes shall be furnished and set under Item 21, and holes for such pipes shall be drilled under Item 20. This work shall be done in accordance with the specifications under this item and Sections 14G.1 to 14G.38, inclusive, in so far as they are applicable.

Contractor not  
relieved of  
responsibility.

SECT. 19.2 The compliance of the Contractor with orders to apply protective coatings of cement mortar shall not relieve him of his responsibility to maintain all portions of the work in a safe condition, as provided in Section 21.

Materials.

SECT. 19.3 Sand for the protective coatings of cement mortar shall conform to the requirements of Section 14G.5 and shall be so graded in grain size and have such moisture content as to be best suited for the work. The cement shall be Portland cement of the quality specified in Item 24 and the water shall be as required in Section 14G.12.

Mixing.

SECT. 19.4 The relative proportions of sand and cement shall be adjusted to the requirements of the work so as to produce protective coatings of greatest density. The sand and the cement shall be measured by volume and thoroughly mixed in an approved machine for a period of not less than one minute and then promptly placed by a pneumatic machine in the coatings, so as to avoid partial setting of the cement. Mixed sand and cement remaining in the machine longer than 30 minutes after mixing shall be discarded and no payment shall be made for such discarded sand and cement. Mixing of mortar ingredients by hand will be allowed only in special cases by specific permission of the Engineer. All proportions and operations of mixing shall be subject to the orders of the Engineer.

Application  
of coatings.

SECT. 19.5 For applying the coatings, the Contractor shall provide apparatus of approved design which will apply the materials by means of pneumatic pressure. Facilities shall be provided for metering and controlling the addition of water to the sand and cement. Air shall be provided in sufficient volume and under such pressure as may be necessary for the best operating conditions. In applying the cement mortar, the discharge nozzle shall be held so that the stream of material shall impinge, as nearly as possible, perpendicular to the surface being coated, and the velocity of discharge from the nozzle, the distance of the nozzle from the face, and the amount of water used shall be regulated so as to produce a dense

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coating with the minimum rebound of material and no sloughing. Rebound-  
ing material shall not be used again but shall be removed from the work  
and disposed of by the Contractor as a part of the work under this item.  
If, in the opinion of the Engineer, the amount of rebound is excessive,  
such excess as estimated by him shall not be included for payment. In  
general, cement mortar coatings shall have a thickness of not less than  
1/2 inch except that a lesser thickness will be permitted on projecting  
points of rock, but greater or lesser thicknesses may be ordered. Wherever  
a coating is to be applied upon one previously placed, only sufficient time  
shall elapse between applications to insure that the material will not  
slough off. In case an additional coating is ordered over a previously  
placed layer which has set, the surface of the first layer shall be cleaned  
by means of air and water jets before starting work.

Thickness of  
coatings.

Additional  
coatings.

Equipment and materials for applying protective coatings of cement  
mortar shall be ready and available as sections of the rock excavations  
progress. Ordered protective coatings shall be placed as soon as practi-  
cable after exposure of the sections of rock upon which they are to be  
applied.

Equipment and  
materials to be  
available.

SECT. 19.6 Protective coatings of cement mortar shall be kept moist  
continuously by sprinkling with water for a minimum period of seven days,  
unless an equally effective method of curing is approved by the Engineer.  
Sprinkling may be required to begin as early as three hours after the plac-  
ing of each section of protective coating.

Curing.

SECT. 19.7 The quantity to be paid for under Item 19 shall be the  
number of cubic yards of protective coatings of cement mortar satis-  
factorily placed in the work in accordance with directions, measured as  
the sum of the volumes of cement and sand before mixing, with no de-  
ductions for rebound except that amount of rebound which, in the opinion  
of the Engineer, is excessive. In determining the volume of cement, 105  
pounds of cement will be considered as one cubic foot. The volume of the  
water added to the cement and sand shall not be taken into consideration  
in the measurement of the volume to be paid for under this item. The price  
per cubic yard stipulated for this item shall include all labor, equipment,  
materials, expenses, and costs, not properly to be classified under any  
other item or items, necessary to completely perform the work to be done  
under this item in the manner herein set forth and specified. Cement will  
be paid for under Item 24 and sand under Item 27, except for deductions  
due to excessive rebound as herein specified.

Measurement  
and payment.



## GROUTING

See Items 1, 20, 21, 22, 23, 24, and 27

## GENERAL CONDITIONS AND REQUIREMENTS

Explanation  
of grouting  
items.

SECT. 20G.1 All work of grouting required in constructing the waste weir and the weir and waste channels, filling seams in rock of the dam foundation, sealing the plug in the diversion conduit, and for any other purpose as may be deemed necessary, shall be done under the following items: Item 1, provides for core borings in rock or masonry; Item 20, for drilling holes in rock or masonry; Item 21, for steel pipes for grouting; Item 22, for making connections for grouting; Item 23, for mixing and placing grout; Item 24, for Portland cement; and Item 27, for sand for grout.

Purpose of  
grouting.

SECT. 20G.2 Grout is to be used to impregnate and make strong and watertight any porous, weak, or shattered rock; to fill seams in the rock; to make the rock in designated areas impervious; to fill any voids between the rock and the masonry structures; to fill spaces about metal work; to fill construction joints in concrete or masonry; to fill core boring holes and wells in rock; or for such other purposes as the Engineer may direct. Important uses of grouting will be to consolidate the rock formations in and adjacent to the excavations for the waste weir, and weir and waste channels, to stop inflows of water that may be encountered in the rock excavations or which may develop subsequently, and to seal the plug in the diversion conduit. Grouting of the rock shall be done in stages with plugs or packers to confine the input of the grout to designated portions of the holes. Such stage grouting shall be done, as ordered, for pregrouting the rock before any rock excavation is done at the locations specified herein, for grouting the rock after excavation may have revealed the need for further grouting, and for grouting the rock and concrete masonry after the latter has been placed.

Plant and  
materials in  
readiness.

Any or all  
other work  
may be  
stopped for  
grouting  
operations.

SECT. 20G.3 All plant and equipment and all requisite materials for grouting shall be in readiness to promptly do all required grouting at such times and places as may be necessary. The assembly of plant and devices for grouting, the supplying and storing of materials, and the order of grouting work in connection with the work under other items shall be such that, so far as practicable, operations under all items may be carried on without interference; but the importance of promptly grouting off inflows of water may be such that any or all other work that may interfere directly or indirectly with the grouting operations may be ordered stopped. For such ordered stopping of work the Contractor shall receive no compensation

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other than that included in the various items of the contract, nor any extension of time, such stopping of work being deemed an ordinary delay under the terms of Article VI.

## DRILLING HOLES IN ROCK OR MASONRY

### ITEM 20

SECT. 20.1 Under Item 20 the Contractor shall drill holes in rock or masonry, penetrating embedded steel, if encountered, for grouting, for inspection of grouting, for the insertion of anchor bolts, for the insertion of steel pipes as drains, or for other purposes, wherever directed. The holes shall be vertical or inclined, as required, and the diameter shall be from one inch to 2½ inches, inclusive, except that holes for weep pipes and the first three to five feet of any hole for grouting may be ordered drilled to a larger size up to 3½ inches in diameter. Holes shall not be smaller in diameter than the size ordered, and not more than 1/2 inch larger. The diameter of the holes for anchor bolts for anchoring rock shall be that required for properly installing such bolts. Holes shall be thoroughly cleaned out before being used. This item shall not include, however, holes one inch or less in diameter for small anchor or expansion bolts; such holes shall be considered as appurtenant to the metal or other work to be attached and shall not be directly estimated for payment. Work included.

SECT. 20.2 The location, length, and direction of each hole for grouting shall be as directed by the Engineer. These holes shall permit the insertion of, and temporary sealing with, an approved type of plug or packer at designated depths within any hole, and the subsequent removal and reinsertion of such plug or packer. Unless otherwise ordered or approved, each hole for grouting shall be wet drilled using water under an approved pressure, and shall be protected at the surface with an approved collar to prevent the drill cuttings and other material from being washed back into the hole. After completing the drilling of each hole, the collar shall be capped or the hole otherwise satisfactorily protected. Holes for grouting.

SECT. 20.3 The quantity to be paid for under Item 20 shall be the actual number of linear feet drilled in accordance with orders, no hole, however, being reckoned as less than one foot in length. The price per linear foot stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. Metal pipes Measurement and payment.

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and caps used for approved collars will be paid for under Item 21. No payment will be made under this item for holes drilled for the excavation of rock or masonry, including line holes, but the cost thereof shall be considered as having been included in the price stipulated for Item 4.

## STEEL PIPES FOR GROUTING

### ITEM 21

Work  
included.

SECT. 21.1 Under Item 21 the Contractor shall furnish and set steel pipes, as directed, in holes drilled under Items 1 and 20, in rock or masonry, in masonry during various stages of construction, or in other approved places, for grouting, for vent pipes, for pipe collars, for drains, for tests, or for other purposes. As a part of the work under this item, the Contractor shall furnish, place, and remove cast iron plugs as may be necessary for the care of water or for grouting, or to keep concrete from entering the grout pipes or fittings; shall do any drilling, rodding, or other work in connection with keeping the pipes clear, including drilling of pipes for any ordered regrouting, and shall do any work and furnish all materials required in connection with keeping the pipes in position.

Pipes for  
grouting.

Fittings  
and work  
required.

SECT. 21.2 The pipes for grouting shall be of steel, of the iron pipe size ordered which in practically all cases, except pipe collars, will be 1½ inches but in no case larger than 3 inches. Each shall be fitted, in general, at the end which will be adjacent to the finished surface of the masonry, with terminal fittings consisting of a standard steel coupling and a cast iron plug. Any other standard steel or cast iron fittings shall be supplied, as required, for the effective installation and use of the pipes; and all cutting, including beveling or notching vent pipes at the ends adjacent to the rock, required for their subsequent use as grout pipes or for other purposes, and all threading, bending, and fitting necessary to erect all pipes complete, as ordered, shall be done.

Installing  
pipes.

SECT. 21.3 Steel pipes for grouting shall be set with such frequency and in such locations as will make for complete filling with grout of all spaces that are to be grouted and, to make for direct and effective placing of grout, the lengths of pipes shall be as short as practicable. Where pipes are set in holes drilled in rock or masonry, secure and watertight joints shall be made between the pipes and the sides of the holes by caulking with oakum or by other acceptable means. Where pipes are to be built into the masonry, the terminal fittings shall be kept entirely within and at least 1/2 inch from the finished face of the masonry, and suitable

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wooden or other terminal plugs or forms shall be provided to prevent the concrete from surrounding and covering the ends of such fittings. The furnishing and placing of such plugs or forms shall be included in the price stipulated for this item. Other plugs, of oakum or other approved material, shall be provided to prevent concrete from entering the pipes and fittings at the ends adjacent to the rock, and the removal of such plugs shall permit the passage of grout through the pipes. All pipes for grouting shall be so firmly fixed in position that they will not be disturbed in the concreting or other operations. Steel pipes for drains, for tests, for pipe collars, and for other purposes shall be set firmly in position at the locations designated by the Engineer.

SECT. 21.4 The quantity to be paid for under Item 21 shall be the number of linear feet of steel pipes furnished and set in accordance with directions, with the additional allowances for fittings hereinafter stated: For each coupling, each elbow, whether 90 degrees or 45 degrees, each tee, each bushing, and each cap, one foot, and for each cross, Y-branch, or malleable iron union, two feet of pipe will be estimated. In measuring the lengths of pipes, no deduction will be made for the lengths of included fittings. The price per linear foot stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to furnish and set in the work steel pipes of the kind and quality specified and in the manner herein set forth. Pipes used for grouting previous to excavation, though removed before completion of the work, shall be included for payment under Item 21 and shall become the property of the Contractor. No separate allowance will be made for cast iron plugs or for nipples; the former will be considered as having been provided for in the allowance for the fittings in which they are used; the latter will be included in the lengths of pipes measured. No separate payment will be made under this or any other items for wooden plugs or forms, nor for oakum or other materials used in setting the pipes furnished and placed under this item, but the cost thereof shall be considered as included in the price stipulated for Item 21.

Measurement  
and payment.

**REVISED**  
SEE ADDENDUM

**REVISED**  
SEE ADDENDUM

## MAKING CONNECTIONS FOR GROUTING

### ITEM 22

SECT. 22.1 Under Item 22 the Contractor shall make hose connections from the pumps for injecting grout to any pipes set under Item 21, as directed. Under this item, also, he shall disconnect and clean the hose, shall furnish and set a straightway valve or plug cock on each pipe, including both those to which the grout pump is to be attached and those to

Work  
included.



be used as vents or indicators, shall remove such valves or cocks when the grout shall have sufficiently set, shall install cast iron screw plugs in those pipes which leak or drip, and shall acceptably point all depressions in exposed surfaces of masonry due to the presence of the pipes.

Description  
of connections.

SECT. 22.2 Connections shall be made by suitable screw joint fittings, and shall be amply strong and so tight as to prevent leakage of grout under the required grouting pressures. Each valve or cock shall have a free opening of area equal to the bore of the pipe. Connections may have to be made with more than one size of pipe.

Covering  
pipes.

SECT. 22.3 Pointing over the ends of pipes in masonry shall be done with mortar mixed and applied as ordered, and so finished that the exposed masonry faces shall be as smooth as though no pipes had been set.

Measurement  
and payment.

SECT. 22.4 The quantity to be paid for under Item 22 shall be the number of connections estimated as herein specified. The work done in connection with any pipe is much more in the case where the pump for injecting grout is attached to the pipe, than in the case where no attachment is made and the pipe is used solely as an indicator or a vent. In the measurement under Item 22, one connection will therefore be included for each of the pipes with which the grouting pump is actually connected and one connection for each three of the other pipes used solely as indicators or vents, subject to the provisions that the connection shall have been made in accordance with orders and the grouting done to the extent at that time directed. If any ordered connection is made to a pipe, and if grouting is not done through this connection for any other reason than the fault of the Contractor, such connection shall be estimated for payment, and any reconnection for the purpose of an ordered regrouting, after a pipe has been once grouted to the extent then desired, shall also be estimated for payment. The price per connection stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. Cement used in the mortar for pointing over the ends of the pipes will be paid for under Item 24.

## MIXING AND PLACING GROUT

## ITEM 23

SECT. 23.1 Under Item 23 the Contractor shall mix and place, with or without the application of pressure, grout of cement and water, with or without sand, in the proportions directed, to fill seams, voids, or spaces and for other purposes, as described in Section 20G.2 and as ordered. As a part of the work under this item, the Contractor shall thoroughly clean out each hole immediately prior to grouting, using water under pressure as ordered or approved; shall furnish, insert, seal, and subsequently remove approved type plugs or packers at designated depths within the holes, and do stage grouting, as ordered; and shall do any drilling, rodding, or other work in connection with keeping grout pipes clean, including drilling the pipes for any ordered regrouting. All requisite precautions to prevent the setting of grout which may escape upon the exposed surfaces of the masonry, and all measures necessary for the removal of grout which may have adhered to such surfaces and for restoring such surfaces to their original condition, shall be included in the work under this item. All pressure grouting shall be done with direct acting power driven pressure pumps, except as small quantities of grout may be placed by other means, as permitted. Work included.

SECT. 23.2 Portland cement of the quality specified under Item 24 shall be used for grout. The quality of the sand required is specified in Section 27.3. Grout shall be mixed of a consistency suitable for the work in hand and constantly agitated. Grout for filling fine seams in the rock or other narrow spaces shall be neat cement and water. Such grout shall generally be very dilute, not infrequently so thin as to be "cement milk". Cement for such dilute grout shall be screened, if so directed, to remove the coarser particles. Grout for filling larger spaces shall generally contain sand and shall be as thick as can with certainty be made to flow unimpeded and to fill completely all the voids in the rock and all the spaces behind the masonry. All materials shall be entirely free from lumps when put into the mixer. Materials and mixtures.

SECT. 23.3 The placing of grout shall, unless otherwise expressly ordered, be prosecuted continuously until completed to avoid disturbance of grout which has taken an initial set. The grout pumps shall be so operated and controlled that the grout will be delivered uniformly and steadily. The sequence of grouting and the consistency of the grout shall Placing grout.

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be as ordered or approved and shall be such as to insure that the spaces have been completely filled. Regrouting of seams or spaces once grouted shall be done as frequently as may be directed to meet the rigid requirement that all voids be filled completely with grout.

Grouting pressures.

SECT. 23.4 The grouting pressures shall be as ordered and as are appropriate to the work in hand. Care shall be taken to avoid lifting the rock strata or otherwise damaging or weakening the rock structure or injuring the masonry. The time of beginning grouting operations and the method of conducting such operations shall be as directed.

Grouting to be done as directed.

Measurement and payment.

SECT. 23.5 The quantity to be paid for under Item 23 shall be the actual number of cubic yards of grout mixed and placed in the work in accordance with directions. Grout shall be measured in its liquid state before placing in the work, and the Contractor shall provide water meters and other suitable means for convenient measuring. If, in the opinion of the Engineer, there is avoidable waste of grout, the volumes of grout, sand, and cement thus wasted, as estimated by him, will not be included in the quantities to be paid for. No payment will be made under this item for grout used for work under Items 16, 17, and 18, but the cost thereof will be considered as included in the prices stipulated for those items. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. Holes drilled in rock or masonry for grouting will be paid for under Item 20, steel pipes and fittings for grouting will be paid for under Item 21, connections for grouting will be paid for under Item 22, cement will be paid for under Item 24, and sand for grout will be paid for under Item 27. No separate payment will be made under this or any other item for any ordered drilling of grout pipes necessary for regrouting, for washing out each hole with water under pressure, for plugs or packers used for stage grouting, or for any other special grouting equipment, but the cost thereof shall be considered as included in the price stipulated for Item 23.

Deduction of waste.

## PORTLAND CEMENT

### ITEM 24

Portland cement.

SECT. 24.1 Under Item 24 the Contractor shall furnish, deliver, and place in the work Portland cement that has been manufactured at established American plants of such recognized capacity and quality of output as to insure a product at least equal to that hereinafter specified. Unless

otherwise permitted, cement from not more than three plants shall be used and, in general, only the product of one plant shall be used at the same time in any section of the work. Within 15 days following the notice to begin work the Contractor shall submit for the approval of the Engineer the names of the plant or plants from which he proposes to furnish the cement and no cement shall be furnished from any plant until it has been approved. At the same time, he shall also furnish to the Engineer an estimated schedule of the monthly deliveries he will require from each of the said plants during the ensuing four months. This schedule shall be revised by the Contractor every 60 days thereafter.

SECT. 24.2 The cement and the clinker from which it is made will be subjected to thorough inspection, to tests, and to frequent analyses as provided in the following sections. The cement when delivered and used on the work shall be dry and free from lumps and caking.

General requirements.

SECT. 24.3 The raw materials from which the cement clinker is made shall be thoroughly blended and finely and uniformly ground; either the dry or the wet process may be used. The flue dust from the kilns shall not be returned to the raw mix, but shall be rejected unless the nature of the raw materials and of the flue dust is such that the alkalinity of the finished cement is less than 3.8 and its content of free alkali is less than 3.5. (See Section 24.8 for test procedures). The kilns shall operate at about 2,700 degrees Fahrenheit and a continuous record of the temperature shall be kept. A regular record shall also be kept of the rates of kiln rotation; these records shall be available to the Engineer and are called for in order to insure the greatest possible uniformity of kiln output. The speed of kiln rotation and kiln temperature shall be controlled and coordinated so as to produce a hard and completely burned clinker in which the combinations between the several oxides it contains have been substantially completed. Only a minimum of water may be used as an aid for cooling the clinker while it is hotter than dull red; at all other stages it shall be kept dry and protected from the weather. In general, the clinker shall be ground immediately after it has been made; occasionally it may be stored, but not for a period longer than six weeks. Grinding aids shall not be employed unless they have been declared to and approved by the Engineer. No water or steam shall be permitted to come into contact with the cement or applied to it during or after the grinding of the clinker. The gypsum or other source of SO<sub>3</sub> shall be reasonably dry when mixed with the clinker before grinding. No material or admixture shall be added to the raw material, to the clinker, or to the cement at any stage of the manufacturing process without the approval of the Engineer, except that gypsum, anhydrite, or plaster may be added in quantities sufficient to secure the

Requirements of manufacture.

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necessary percentage of sulphuric anhydride. Water may be added to the clinker only as above provided.

Fineness and  
temperature  
of grinding.

Soundness  
of neat ce-  
ment pats.

Time  
of set.

SECT. 24.4 The cement shall be ground so that at least 90 percent, but not more than 98 percent, by weight, will pass the standard No. 200 sieve. These limits shall not be exceeded. At no time subsequent to mixing of clinker and gypsum shall the temperature of the material during pulverizing or grinding exceed 230 degrees Fahrenheit, nor shall the temperature of the finished cement exceed this limit. Pats of neat cement, in the steam test for soundness, shall remain firm and hard and shall not distort, check, crack, or disintegrate. Similar pats kept in the moist closet for seven days shall remain firm and hard and unchanged. The cement shall not develop its initial set under the Vicat needle in less than 45 minutes or in less than 60 minutes when the Gillmore needle is used. The final set shall be attained in not more than eight hours.

Tensile  
strength.

SECT. 24.5 The average tensile strength of not less than three standard briquettes made of neat cement and mixed to normal consistency shall not be less than the limits stated in the following table:

AGE AT TEST IN DAYS	STORAGE OF BRIQUETTES	TENSILE STRENGTH, POUNDS PER SQUARE INCH
1	1 day in moist closet .....	300
7	1 day in moist closet, 6 days in water	600

The average tensile strength of not less than three standard mortar briquettes made of one part of cement and three parts of standard Ottawa sand, measured by weight, shall not be less than the limits stated in the following table:

AGE AT TEST IN DAYS	STORAGE OF BRIQUETTES	TENSILE STRENGTH, POUNDS PER SQUARE INCH
7	1 day in moist closet, 6 days in water	275
28	1 day in moist closet, 27 days in water	375

The average tensile strength of the mortar briquettes at 28 days shall be at least 15 percent greater than the average tensile strength at seven days.

SECT. 24.6 The composition of the cement shall be such that the chemical analyses will show it to meet the limits stated below: Composition of cement.

The percentage of silica ( $\text{SiO}_2$ ) shall not be less than 21.50;

The percentage of alumina ( $\text{Al}_2\text{O}_3$ ) shall not be greater than 5.60;

The percentage of magnesia ( $\text{MgO}$ ) shall not be greater than 4.00;

The percentage of sulphuric anhydride ( $\text{SO}_3$ ) shall not be greater than 1.75;

The percentage of loss on ignition shall not be greater than 0.90;

The percentage of insoluble residue shall not be greater than 0.30;

The ratio between the percentage of alumina ( $\text{Al}_2\text{O}_3$ ) and the percentage of ferric oxide ( $\text{Fe}_2\text{O}_3$ ) shall not be greater than 1.60 nor less than 1.20;

The ratio between the percentage of lime ( $\text{CaO}$ ) and the percentage of silica ( $\text{SiO}_2$ ) shall not be greater than 2.90;

The molecular ratio (Colony's Ratio) shall not be greater than 2.60 unless approved by the Engineer. This ratio is obtained by dividing the molecular ratio of the calcium oxide by the sum of the molecular ratios of the silica, the alumina, and the ferric oxide.

SECT. 24.7 All chemical analyses and physical tests specified in the preceding sections shall conform to the latest revisions of the following procedures: Chemical analyses and physical tests.

AMERICAN SOCIETY FOR TESTING MATERIALS DESIGNATION	
Methods of Chemical Analyses of Portland Cement	C 114
Method of Test for Fineness of Hydraulic Cement by the No. 200 Sieve .....	C 184
Method of Test for Normal Consistency of Hydraulic Cement .....	C 187
Method of Test for Soundness of Hydraulic Cement over Boiling Water (Pat Test) .....	C 189
Method of Test for Tensile Strength of Hydraulic Cement Mortars .....	C 190
Methods of Test for Time of Setting of Hydraulic Cement by the Vicat or Gillmore Needle .....	C 191



All limits prescribed in these specifications include all so-called "tolerances". At least 14 days shall be allowed for the completion of the 7-day tests, and the 28-day tests shall be completed within 32 days.

**Alkalinity.**

SECT. 24.8 The alkalinity of the cement shall not be greater than 3.8 and its content of free alkali shall not exceed 3.5. These characteristics shall be determined as follows: Weigh out 800 grams of cement and put into an enameled saucepan with 500 c.c. of distilled water. Stir frequently for two hours, then filter through large folded filter paper for ten minutes. If filtrate is not clear, refilter. Titrate 25 c.c. of the filtrate with N/2 HCl, using methyl orange as the indicator. The number of c.c. of acid required to neutralize the filtrate to the methyl orange end point is the measure of the alkalinity.

**Free alkali content.**

The free alkali content of the cement shall be determined as follows: Measure out 100 c.c. of the filtrate obtained in the alkalinity test of the preceding paragraph into a small beaker and add 30 to 35 c.c. of a saturated filtered solution of Ba (OH)<sub>2</sub>. Let stand, filter and wash with H<sub>2</sub>O. Pass CO<sub>2</sub> into the filtrate for five minutes. Let stand, filter and wash the precipitate with H<sub>2</sub>O. Heat to boiling and, if a precipitate forms, filter it out. Then boil the total filtrate plus wash water down to about 50 c.c., filter it and make it up to 100 c.c. with distilled water. Now take 25 c.c. of the solution and titrate it with N/2 HCl in the presence of methyl orange. The number of c.c. of the acid required to neutralize the 25 c.c. to the end point of the methyl orange is the measure of the free alkali content. Both of these tests are to be made at room temperature.

**Sodium sulphate test.****Test procedure.**

SECT. 24.9 The cement will be subjected to the sodium sulphate test. In this test the slabs shall, at the end of 28 days, remain firm, hard, and strong and shall show no signs of disintegration or softening. Slight warping or small surface cracks on the edges and corners will not be ground for rejection. The test procedure is as follows: One hundred and fifty grams of the cement are mixed with 43 percent, by weight, of water and stirred for one minute by a rotary stirrer in an earthenware jar about three inches in diameter and four inches high. Near the bottom of this jar is a 3/8-inch diameter hole closed with a cork. When the stirring is complete the mixture is rapidly poured, by withdrawing the cork, onto a sheet of moistened paper as made by the Paterson Parchment Paper Company, of Bristol, Pa., 30-pound 400 Parchment, white, 24 inches by 36 inches, 34.0 pounds per 500 sheets, or approved equal, cut to eight inches by ten inches, the paper being supported on a clean glass plate eight inches by ten inches in size. On this paper at convenient positions are placed six 3/16-inch steel balls held in position by paraffin shavings. The poured

slab assumes an oval shape about four inches by eight inches in size. A second glass plate, also having a moistened parchment paper on its face, is then gently lowered into position on the steel balls so as to exclude all air bubbles. A light weight (two soundness pats are sufficient) is then placed on top of the upper glass plate and the assembly carefully put into the moist closet. Twenty-four hours thereafter, the assembly is put into the water storage tank (circulating water). After another 24 hours the glass plates and papers are removed and the slab carefully sawn to size, two inches by four inches, with a hacksaw and templet, it being kept under water except during the sawing process. At this time a small hole is also drilled through the slab at 1/2 inch from one end and on its center line. This hole serves to suspend the slab in the test solution. The slab then goes back into the water storage tank for 24 hours, when it is removed and hung on a copper hanger in a 2-quart Mason jar containing 1,500 c.c. of a 10-percent, by weight, solution of anhydrous sodium sulphate ( $\text{Na}_2\text{SO}_4$ ). The slab is suspended so that its top is one inch below the surface of the solution. About ten drops of an alcohol solution of phenolphthalein are added to the sulphate solution and, after the slab has been placed therein, it is titrated every 24 hours to the phenolphthalein end point with 6N sulphuric acid. During the test the jars are covered with glass tops without washers, except when the titration is being done. During that process the slab is removed and hung in an empty jar close at hand. A daily record of the quantity of acid added is kept. A sudden increase in the quantity of acid consumed is an indication of failure of the slab before cracks visible to the eye appear. This test is to be made at room temperature.

SECT. 24.10 The sugar solubility of the cement shall not be greater than 8.0 to the phenolphthalein end point, nor greater than 10.0 to the final clear point. These values shall be determined as follows: A sample of about 100 grams of the cement is passed through the 200-mesh screen and put into a glass bottle closed with a rubber stopper. From this bottle 15 grams are then weighed out and placed into a Nessler tube containing 100 c.c. of a 15 percent solution of cane sugar in distilled water (commercial granulated sugar such as "Jack Frost"); this solution shall not be more than three days old. The tube and its contents are then quickly shaken by hand and placed on a wheel revolving about 60 times per minute. At the end of about one hour and 50 minutes the mixture is poured into a filter paper and funnel and allowed to filter for ten minutes when the beaker containing the filtrate is removed. (In case the filtration time of ten minutes is too short to produce a volume of filtrate of 30 c.c., it may be lengthened by shortening the time of shaking, but the total time from the putting of the sample into the solution to the end of the filtration must be exactly two hours). Twenty-five c.c. of the filtrate are now titrated

Sugar test.



with N/2 HCl in the presence of phenolphthalein and the number of c.c. of acid to the end point is the first measure of the sugar solubility. At this stage of the test, in the case of a thoroughly burned cement which has been kept dry, the solution will be practically clear and only traces of ferric oxide and alumina will be in suspension. In the case of an under burned cement, or one which has been exposed to moisture, the solution will be heavily clouded and the end point must be approached slowly and with caution. When so performed, the phenolphthalein end point can be definitely determined, as the color changes from light pink to yellow. The titration is then continued until the solution is crystal clear and nothing remains in suspension. The total number of c.c. of acid from the beginning of the titration to this final clear point is the second measure of the sugar solubility. This test shall be made at room temperature. In addition to disclosing the quality of the cement as above stated, this test further indicates the character of the hydration products which will be realized in the completed concrete.

**Shipment  
of cement.**

SECT. 24.11 Cement shall be delivered in strong, well-made, 4-ply paper packages, each plainly marked with the manufacturer's brand. The weight of all packages shall be uniform. Packages received in broken or damaged condition shall be rejected, or accepted only as fractional packages. If so required, each package of cement shall be stamped at the expense of the Contractor, under the supervision of, and with a stamp furnished by the Engineer. With the approval of the Engineer, cement may be delivered in bulk if the Contractor provides approved storage, weighing devices, and all other necessary facilities to insure keeping the cement in good condition and affording a correct measure of the cement used in each batch, as well as in total quantity. Bulk shipments shall be made only in weathertight cars, trucks, or containers which shall be free of loose cement or other residue. Loading facilities shall be such that the cement will be protected against entry of moisture at all times. Cars, trucks, or containers shall be sealed after loading, at the expense of the Contractor, under the supervision of, and with seals furnished by the Engineer.

**Quantity  
on hand.**

SECT. 24.12 The Contractor, at all times, shall have at the site of the work a sufficient supply of accepted cement and shall guard against possible shortage from every cause.

**Inspection  
and tests.**

SECT. 24.13 The Engineer shall be notified by the Contractor when the cement is to be manufactured, and the Engineer shall have the liberty at all times to inspect the materials, the processes of manufacture and the

laboratory records of analyses and tests made at the cement works, and to supervise the packing. Samples will be taken at the place of manufacture by the Engineer and sent to the Board's laboratory, where the tests and analyses herein specified will be made. Samples shall be stored and shipped in moistureproof, airtight containers which will be furnished by the Board. These containers shall be crated, ready for shipment, by the Contractor and shall be delivered by him to the express company. Express charges will be paid by the Board.

Samples.

SECT. 24.14 The Contractor shall notify the Engineer when orders for cement are placed and shipments are to be made in ample time (at least 48 hours) to enable him to have his representative present to observe the burning of the clinker, the manufacture of the cement, its loading for shipment and to obtain the necessary samples. In case additional tests become necessary, the Contractor shall rehandle the cement in the storehouse for the purpose of obtaining samples as directed.

Notice of shipments of cement.

In general, the cement shall be sampled from the conveyor belt at the mill by a continuous sampler, one sample being taken for every 200 barrels or more as determined by the Engineer. Each sample shall weigh five pounds. If sampled from the bin proper, tubes shall be used. If a bin is full, it shall be sampled from the discharge openings. The methods of sampling must at all times be approved by the Engineer. All cement stored at the mill shall be kept in sealed silos or other approved bins.

Sampling and storage.

Cement kept in storage at the mill for more than six months may be retested. Cement failing to pass such tests shall be rejected. If any cement proves unsatisfactory and portions of it have been used in the masonry, such masonry shall be ordered removed and replaced with masonry built of acceptable cement at the Contractor's expense. Test cylinders from concrete or mortar being used in the work shall be made by the Contractor at any time for purposes of test, if so directed.

Retesting.  
Rejected cement.

SECT. 24.15 Cement may be rejected at the discretion of the Engineer if it fails to meet any of the requirements of these specifications. Cement may be accepted without awaiting the results of the 28-day tests when, in the judgment of the Engineer, the 7-day tests are met and there is definite justification, based on experience and actual plant performance, that the 28-day tests will be satisfactory.

Rejection or acceptance of cement by Engineer.

SECT. 24.16 The Contractor shall provide suitable storage for cement at approved places convenient to the work, and the cement shall at all times be carefully and in a workmanlike manner protected by him

Storehouses for cement.



Scales for  
weighing.

against moisture and exposure to the air. Cement storehouses shall be weathertight, shall have tight floors a proper distance above the ground, shall be large enough to admit of keeping on hand a sufficient supply of cement to prevent delays or interruptions to the work, and shall have sufficient floor space for storing each carload, truckload, or bargeload of cement separately and affording convenient access thereto for sampling, counting of packages, and removal. Cement in packages shall not be piled to a height exceeding seven feet. Suitable, accurate scales shall be provided by the Contractor for weighing the cement in each storehouse and elsewhere on the work, if required, and he shall also furnish all necessary test weights. Bulk cement shall be stored in weathertight bins or silos, plans of which shall be submitted by the Contractor for the approval of the Engineer and they shall be efficiently operated and maintained by the Contractor. All such storage bins shall be constructed so that there will be no dead storage. The Contractor shall not use cement directly upon its receipt whenever cement previously received has been in store more than 15 days.

Cement  
storekeepers.

SECT. 24.17. The Contractor shall employ competent storekeepers who can speak and understand the English language, who shall have charge of the cement storehouses and keep suitable records of the delivery and use of all cement. Copies of these records shall be furnished the Engineer at the close of each day's work, showing in such detail as he may require, the quantity of cement used during the day at each part of the work.

Measurement  
and payment.

SECT. 24.18 The quantity to be paid for under Item 24 shall be the number of barrels of Portland cement of the kind and quality herein specified, which have been furnished and delivered to the work by the Contractor and used in accordance with this contract, measured as follows: Four bags, each containing 94 pounds net of cement, shall, for purposes of payment, constitute a barrel of cement weighing 376 pounds net. No payment will be made for any excess weight over 376 pounds net per barrel. Shipments in which more than five percent of the bags weigh less than 94 pounds net may be rejected. Bulk cement shall be weighed under the supervision of the Engineer on approved scales furnished by the Contractor and tested as required. Every 376 pounds shall constitute a barrel. The price per barrel stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to furnish, deliver, and place in the work Portland cement of the kind and quality specified

and in the manner herein set forth. Cement used for joints of pipes and fittings, for replacing condemned work and filling unauthorized excavations, for manufacturing and placing concrete blocks, for manufacturing concrete culvert pipe, and that used for the purposes of the Contractor, shall not be included for payment under this item, it being considered that the cost of furnishing and delivering all such cement has been included in the prices stipulated for the various other items of the contract.

### RUN OF BANK GRAVEL

#### ITEM 25

SECT. 25.1 Under Item 25 the Contractor shall furnish, place, and compact run of bank gravel for foundations, pavements, and shoulders, as shown on the drawings or ordered, for the permanent access roads to the release water chamber and to and along the top of the dam, for the reconstruction of a portion of the town road, and for any ordered repairs, regrading, or resurfacing of designated portions of the existing access roads, and shall furnish, place, and compact run of bank gravel for the drain at the downstream portion of the south abutment of the dam, as shown on the drawings, and for other purposes as ordered. As a part of the work under this item, the Contractor shall prepare the fine grade upon which the run of bank gravel is to be placed for road foundations, pavements, and shoulders and shall maintain in good condition the gravel pavements and shoulders constructed or repaired under this item and shall place them in first class condition at the completion of the work under this contract. Work included.

SECT. 25.2 All run of bank gravel shall be of hard, durable stone and well graded. Except as otherwise specified herein, the particles shall be of such size as will pass through a 4-inch square hole, with 30 to 65 percent passing a No. 4 mesh sieve and not more than 10 percent passing a No. 200 mesh sieve and shall be satisfactorily graded. Where the compacted layer of run of bank gravel is thicker than six inches, the Engineer may permit the use of gravel containing stones of greater size than above specified. Should the gravel, at any time during the work and for any reason, fail to maintain suitable proportions of the coarse and fine particles, the Contractor, shall, by the addition of selected material and satisfactory manipulation, produce a material meeting the above requirements. Material.



Drain in  
south abut-  
ment of dam.

SECT. 25.3 Run of bank gravel for the drain at the downstream portion of the south abutment of the dam shall not be placed until the portion of the dam foundation upon which such gravel is to be placed has been prepared in accordance with the provisions of Section 5.2. Except as otherwise approved, run of bank gravel for this drain shall be placed in layers of the thicknesses specified for the placing of semi-pervious embankment under Item 6 and shall be rolled or otherwise compacted as specified under Item 6 for the compaction of semi-pervious embankment.

Preparing  
fine grade  
for roads.

SECT. 25.4 Before any run of bank gravel is placed for road foundations, pavements, or shoulders, the fine grade shall be shaped to line and grade and thoroughly compacted by a roller of approved type weighing not less than ten tons. All hollows and depressions developing during the rolling shall be filled with acceptable material and again rolled, and this process of shaping, rolling, and filling shall be continued until no depressions develop. If the fine grade becomes rutted or displaced due to any cause whatsoever, the Contractor shall regrade the same without additional payment. Old macadam, compacted rock spoil, or other hard material which comes within six inches of the elevation of the finished fine grade shall be removed or, if suitable, plowed, loosened, or scarified to a depth of at least six inches and the loosened material redistributed across the full width of the subgrade, adding suitable material when necessary, so that, when compacted to the required elevation, alignment, and cross section, the fine grade will approach as nearly as possible the condition of uniform density.

Placing run  
of bank gravel  
for roads.

SECT. 25.5 Run of bank gravel for road foundations, pavements, and shoulders shall be evenly spread and rolled in separate layers not over six inches thick after compaction. Placing and spreading shall be done in such manner as will avoid segregation of the materials or pockets of the finer particles and as will maintain satisfactory grading throughout the layer. Compaction shall be done by rolling with an approved roller weighing not less than ten tons. Rolling shall start at the edges, work toward the centerline of the foundation or pavement, and continue until there is no movement in the layer ahead of the roller. Where the ordered total thickness of the gravel after compaction exceeds six inches, the Engineer may approve placing of the second layer after the rolling of the first layer has been completed, without further treatment of the surface. The second layer shall be placed, spread, and rolled as above described, and when the rolling is completed, fine material shall be uniformly spread over the surface, swept into the voids by means of a gang drag broom of an approved type and rolled. The process of filling and rerolling shall be continued with smaller sized material until fine sand or screenings have been used and

the layer has become practically watertight. In every case, rolling shall be continued until no weaving or other movement is discernible under the passage of the roller. The foundation or pavement shall not be laid in lengths exceeding 500 linear feet without being rolled and thoroughly filled so as to prevent the softening of the subgrade. Should the subgrade material become churned up into or mixed with the foundation or pavement through any reason whatsoever, the Contractor, shall, at his own expense, remove such mixture of subgrade material and gravel and replace the foundation or pavement. If the gravel is so dry as to not consolidate satisfactorily, the Engineer may order the addition of sufficient water to secure satisfactory compaction and the cost thereof shall be included in the price stipulated for Item 25.

SECT. 25.6 The quantity to be paid for under Item 25 shall be the number of cubic yards of run of bank gravel, measured after compaction, that have been satisfactorily placed within the limits and of the depths shown on the drawings or ordered. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified. No separate payment will be made for maintaining in good condition the gravel pavements and shoulders constructed under this item, nor for placing them in first class condition at the completion of the work under this contract but the cost thereof shall be considered as having been included in the price stipulated for run of bank gravel measured for payment as specified above.

Measurement  
and payment.

## CRUSHED STONE AND GRAVEL

### ITEM 26

SECT. 26.1 Under Item 26 the Contractor shall furnish, place, and tamp or otherwise compact as ordered, screened crushed stone and gravel for porous backing behind retaining walls and around drainage pipes, for any ordered or approved enlargement or modification of the existing sewage treatment plant, for any ordered additional sewage treatment plant, and for miscellaneous uses not included under other items. The crushed stone and gravel shall be of ordered quality, grading, and sizes.

Work  
included.

SECT. 26.2 Crushed stone and gravel shall be hard and durable, washed to remove all loam, silt, or other objectionable matter, screened to not less than three approved sizes, as directed, and shall be carefully

Quality and  
placing of  
material.



placed in layers. The largest size shall be placed next to the pipes, at the backs of retaining walls, and at the bottoms of filter beds. Succeeding layers shall be graded from coarse to fine, but the depth of layers shall be as ordered or approved.

**Measurement  
and payment.**

SECT. 26.3 The quantity to be paid for under Item 26 shall be the number of cubic yards of crushed stone and gravel actually placed in accordance with directions within the limits prescribed, measured in place after any required compacting. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to furnish and place in the work crushed stone and gravel of the kinds and qualities specified and in the manner herein set forth. Crushed stone or gravel used for concrete masonry, for asphalt concrete pavements, for bedding of rubble paving, for drains back of stone facing, or for other purposes for which payment is distinctly provided under other items, will not be included for payment under Item 26.

**SAND FOR FILTERS, GROUT, AND PROTECTIVE COATINGS OF  
CEMENT MORTAR**

**ITEM 27**

**Work  
included.**

SECT. 27.1 Under Item 27 the Contractor shall furnish, deliver, and place in sewage treatment plant filters to the depths required or as directed, filter sand of acceptable quality and sizes, and shall furnish at convenient points of storage on the work natural sand of the quality specified for grout and protective coatings of cement mortar. Sections 14G.4 and 14G.5 of the specifications for fine aggregate for concrete shall apply equally to the sand furnished hereunder, in so far as they are applicable.

**Sand for  
filters.**

**Screening and  
washing sand.**

SECT. 27.2 The sand for filters shall consist of hard, durable, siliceous grains and any sand containing clay or a large proportion of shale or other soft rock particles will not be acceptable. After discarding such portions as are retained on a screen having not less than eight meshes to the linear inch, the sand shall be satisfactorily screened and washed, and clay, silt, and materials finer than will be retained on a standard 60-mesh sieve shall be removed to the extent herein specified. In these operations, ample volumes of clean water shall be used and, unless otherwise permitted, not less than three washings of the sand will be required, until when dried not more than five percent by weight of the remaining material passes a standard 60-mesh sieve. The volumes of water and the methods

employed shall be such as to give acceptably clean sand of the required grain sizes and uniformity. The sand after treatment shall have an effective size not less than 0.25 millimeter nor greater than 0.35 millimeter. By effective size is meant that grain size of the sand than which ten percent of that sand is finer.

Size of sand grains.

SECT. 27.3 The sand for grout shall be of such fineness that 100 percent will pass a standard 8-mesh sieve, and at least 45 percent by weight will pass a standard 40-mesh sieve. The sand for grout and protective coatings of cement mortar, for convenience in handling and measuring into the mixers, shall, unless otherwise permitted, be put into strong sacks, each containing a standard volume of sand.

Sand for grout.

Sand to be put in sacks.

SECT. 27.4 Sand for filters shall be deposited on the prepared foundations by approved methods that will provide in any section a uniform mass of sand from top to bottom without stratification or unnecessary consolidation and shall be raked level to the required or ordered finished surfaces. The sand shall not be sluiced into place with water, nor placed in layers, nor shall it be tamped, rolled, puddled, or otherwise compacted.

Placing sand for filters.

SECT. 27.5 The quantity to be paid for under Item 27 shall be the number of cubic yards of acceptable filter sand satisfactorily furnished and placed in accordance with requirements or orders, measured in final position in the filters; the number of cubic yards of sand actually mixed for grout placed in the work in accordance with orders and estimated for payment under Item 23, and the number of cubic yards of sand used in placing protective coatings of cement mortar under Item 19. For convenient measuring of sand in sacks by weight, 90 pounds of dry sand shall be considered to be one cubic foot. The price per cubic yard stipulated for this item shall include all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to furnish, deliver, and place in the work sand for filters, grout, and protective coatings of cement mortar of the kinds and qualities specified and in the manner herein set forth.

Measurement and payment.

## ASPHALT CONCRETE PAVEMENT

### ITEM 28

SECT. 28.1 Under Item 28 the Contractor shall furnish all labor, equipment including forms, and materials and shall construct two course

Work included.



asphalt concrete pavement at the locations shown on the drawings or ordered. Typical cross sections are shown on Sheet 21 of the contract drawings.

Plant, equipment, and methods.

SECT. 28.2 The Contractor shall submit to the Engineer the name, location, and description of the bituminous mixing plant which he proposes to use for batching and mixing the asphalt concrete to be furnished and placed under this item and no asphalt concrete shall be delivered to the work except from an approved bituminous mixing plant. The bituminous mixing plant and the equipment and methods to be used for batching, mixing, and transporting the asphalt concrete and for constructing the pavement shall comply with the requirements of Part II, Section 8, of the Public Works Specifications of January 2, 1957 of the State of New York, as revised by all published addenda, except as hereinafter specified and except that all references to "Engineer", "District Engineer", "Deputy Chief Engineer", and "Deputy Chief Engineer (Highways)" shall be replaced by the word "Engineer" having the meaning given in Article I of this contract, and all references to "Department" shall be replaced by "Board of Water Supply".

Materials, proportioning, and mixing.

SECT. 28.3 The Contractor shall manufacture the asphalt concrete by any one of the three options specified under Item 51M-Asphalt Concrete, of the Public Works Specifications of January 2, 1957 of the State of New York. The materials, preparation of aggregates, proportioning, and mixing shall comply with the requirements of the specifications of one of the following three items of the said Public Works Specifications, revised by all published addenda, as appropriate for the option selected by the Contractor:

Item 51 - Asphalt Concrete - Type 1A

Item 53 - Asphalt Concrete - Type 3A

Item 53C - Asphalt Concrete - Type 5A, either Method

No. 1, Cold Process, or Method No. 2, Heated Process.

However, dusting the surface of the top course of the asphalt concrete pavement with Portland cement or fine aggregate is not required and will not be permitted. Wherever the word "Engineer" is used in any of the specifications referred to herein, it shall have the meaning given in Article I of this contract. Prior to constructing any pavement under Item 28, the Contractor shall notify the Engineer as to the option for the manufacture of asphalt concrete that he proposes to use, and he shall furnish samples, as ordered, of the materials to be used.

Item 33 includes: the clad steel release water pipes, clad steel portions of the release water conduit, manholes, and the 12-inch bypass pipe, and other ordered articles of clad steel. Carbon steel flanges and manhole parts, stainless steel washers, threaded fasteners, taper pins and marker plates, and pipe couplings furnished under Item 43 are not included under Item 33.

Item 34 includes: the stainless steel release water pipes, unwatering pipes, flanges, fittings, plates, anchorages, rings, bands, ribs, marking plates, gratings, washers, threaded fasteners, taper pins, and other ordered articles of stainless steel and such appurtenances as herein specified such as insulating sleeves and washers for cathodic protection. This item does not include stainless steel threaded fasteners for pipe couplings furnished under Item 43 nor the parts of anchoring devices that are not of stainless steel.

All joints, other than bolted joints, of the conduit, pipes, appurtenances, and other articles furnished under Items 32, 33, and 34 shall be electric fusion welded, both in the shop and in the field.

The work under these items shall include the furnishing and testing of all materials, the fabrication of the conduit, pipes, appurtenances and other articles, shop and field welding, examination and repair of welds made in the shop, assistance in radiographic examination of field welds, repair of welds made in the field, stress relieving, machining, hydrostatic testing in the shop of those parts for which such testing is called for on the drawings, including approved external supports of pipes for this testing, stress determinations by means of electric strain gages during the shop hydrostatic tests at critical zones of the release water conduit manifold as herein specified, expert supervision, and all electric strain gages, instruments and equipment required for making the stress determinations, a report tabulating the stress determination results, disassembling of portions of the release water conduit as may be required for transportation, preparation for shipment, transportation, storage, erection in the field, cleaning, protection from rust, coatings, gaskets, threaded fasteners, hydrostatic testing in the field of the conduit and all pipes under these items, the furnishing, placing, and removal of all approved test gages, test heads and bulkheads, metal bracing, and supports.

Except in special cases, external support of the conduit and pipes during erection and field hydrostatic testing shall be by means of approved concrete saddles which will ultimately be incorporated in the work and be included for payment in that work. Test heads, bulkheads, bracing, and supports, which are ordered to be removed, shall become the property of the Contractor. All threaded fasteners, approved for hydrostatic testing purposes, shall remain the property of The City.



Attention is directed to Sections 2, 3, and 4 regarding drawings and to Section 32.14 regarding submission of procedure data. The specifications for Items 32, 33, and 34 shall be reproduced and shall be included with the shop drawings submitted for approval.

The computed weights of all parts of work to be included for payment under Items 32, 33, and 34 shall be submitted for approval with the shop drawings, unless otherwise approved. If approved by the Engineer, weights made on certified scales taken in the presence of the Engineer, will be acceptable for certain articles such as threaded fasteners, washers, taper pins, and commercially purchased small flanges, fittings, and pipes less than 12 inches in nominal waterway diameter. Weights of articles to be obtained by weighing do not have to be listed on the shop drawings.

Where ordered, the sequence of welds shall be indicated on the shop drawings. In order to facilitate arrangements to be made by The City for field examination of welds, the Contractor shall notify the Engineer at least four weeks in advance of the time when any field weld will be ready for such examination.

**Materials.**

SECT. 32.2 Steel plates for the release water conduit and backing plates for clad steel, shall fulfill the requirements of the Tentative Specifications for Carbon-Silicon Steel Plates of Intermediate Tensile Ranges for Fusion-Welded Boilers and Other Pressure Vessels, ASTM Designation: A201-57T, Grade B Firebox Steel, of the American Society for Testing Materials. With the exception of the flanges and manhole cover, all plates used in the fabrication of the release water conduit manifold shall conform to the requirements of the ASTM A201 for firebox steel, hereinbefore specified, with the additional requirement that certain of the plates, as shown on the drawings, shall also conform to the requirements of the Standard Specifications for Steel Plates for Pressure Vessels for Service at Low Temperatures, ASTM Designation: A300-58, and the purchase order shall bear the notation that the test pieces shall receive a subsequent stress relieving heat treatment at 1100 degrees Fahrenheit prior to the preparation of the impact specimens. These designated plates shall also be tested and meet the requirements of the Tentative Method and Specification for Ultrasonic Testing and Inspection of Steel Plates of Firebox and Higher Quality, ASTM Designation: A435-59T.

Clad steel, as referred to in these specifications, shall mean steel backing plates with stainless steel cladding of the qualities herein specified. The clad steel shall fulfill the requirements of the Tentative Specifications for Corrosion-Resisting Chromium-Nickel Steel Clad Plate, Sheet, and Strip, ASTM Designation: A264-59T, of the American Society for Testing Materials, and the backing plates shall be ASTM A201,

Grade B Firebox Steel, hereinbefore specified. Stainless steel cladding shall be Type 316L having a carbon content not greater than .03 percent prior to cladding and not greater than .04 percent after cladding. The thickness of the stainless steel cladding shall be not less than 15 percent of the total thickness of the completely fabricated clad steel. The quality of the bond between the cladding and the backing metal shall fulfill the requirements of Section 7 (a) (3) of the above specifications, ASTM Designation: A264-59T. All clad steel used in the fabrication of the pipes so designated on the drawings shall have backing plates that conform to the requirements of ASTM A201 for firebox steel hereinbefore specified with the additional requirement that the plate shall also conform to the requirements of ASTM A300 and A435 hereinbefore specified.

All surfaces of the clad steel plate shall be cleaned and descaled in the mill by means of the sodium hydride descaling process developed by the E. I. DuPont De Nemours and Company, Incorporated, Wilmington, Delaware, in strict accordance with their recommendations consisting of immersion of the metal work in a bath of commercial sodium hydroxide containing from 1½ to 2 percent sodium hydride and operated at a temperature of 700 degrees Fahrenheit, followed by water quenching, baths of acids, and water rinsings. Methods other than the sodium hydride process, for cleaning and removing mill scale from the clad steel plates, may be submitted for approval.

Carbon steel flanges and blind flanges for pipes 24 inches in diameter or smaller, the 18-inch manhole cover, and vent fittings shall comply with the requirements of the Tentative Specifications for Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for General Service, ASTM Designation: A181-59T, Grade II, of the American Society for Testing Materials. Carbon steel flanges and blind flanges for pipes larger than 24 inches in diameter and the 36-inch manhole cover shall comply with the requirements of the Tentative Specifications for Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service, ASTM Designation: A105-59T, Grade II, of the American Society for Testing Materials. Purchase orders for these flanges and fittings shall contain the requirement that all certifications must be signed by an officer of the manufacturer or supplier and include a copy of the manufacturer's test report.

Stainless steel plates, sheets, or strips which are to be used in the fabrication of portions of the pipes for Release Water Pipe Line No. 6, including its branch lines 6A, 6B, and 6C, or are to be used for marking plates, rings, or for other ordered uses, shall meet the requirements of the Tentative Specifications for Corrosion-Resisting Chromium and Chromium-Nickel Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels, ASTM Designation: A240-58T, of the American Society for Test-

Large  
stainless  
steel pipes.



ing Materials, Type 316L, hot rolled, heat treated to meet the mechanical properties of the above designated specification and be capable of meeting the test for resistance to intergranular corrosion. The requirement for the intergranular corrosion test as outlined in Section 12 of the above designated specification shall be incorporated in the purchase order to the mill, and the material furnished shall meet the requirements of this test. The plates shall be blast cleaned or pickled at the mill.

Small  
stainless  
steel pipes.

Stainless steel pipes, for uses other than in Release Water Pipe Line No. 6, and which are less than 12 inches in nominal waterway diameter, shall comply with the requirements of the Tentative Specifications for Seamless and Welded Austenitic Stainless Steel Pipe, ASTM Designation: A312-59T, Grade TP 316L, of the American Society for Testing Materials.

Stainless  
steel  
fittings.

Stainless steel flanges and fittings shall comply with the requirements of the Tentative Specifications for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service, ASTM Designation: A182-59T, Grade F 316L, of the American Society for Testing Materials. Cast stainless steel flanges and fittings may be permitted in lieu of rolled or forged flanges and forged fittings, as approved. Such cast stainless steel flanges and fittings shall comply with the requirements of the Tentative Specifications for Ferritic and Austenitic Steel Castings for High-Temperature Service, ASTM Designation: A351-59T, Grade CF-8M, of the American Society for Testing Materials, modified to limit the carbon content to a maximum of 0.03 percent.

Other metals for the work under Items 32, 33, and 34 shall comply with the requirements of the appropriate Standard or Tentative Specifications of the American Society for Testing Materials, as follows: structural steel where welding is involved - Structural Steel for Welding, ASTM Designation: A373-58T; structural steel for approved bracing or supports or other purposes where welding is not involved - Tentative Specifications for Steel for Bridges and Buildings, ASTM Designation: A7-58T; rivet steel, if required - Boiler Rivet Steel and Rivets, ASTM Designation: A31-55; electrodes used for welding, suitable for the work to be done, of approved size and classifications - Mild Steel Arc-Welding Electrodes, ASTM Designation: A233-58T and Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes, ASTM Designation: A298-55T, as appropriate. Stainless steel and carbon steel threaded fasteners, washers, and taper pins shall be as specified under Section 32.15. All specimens and records shall be furnished and analyses and tests made as provided in the specifications hereinbefore cited. The Engineer shall be informed in advance, of all times of rolling, sampling, and testing and shall be permitted to witness such of these operations as he desires. Duplicate samples shall be furnished to the Engineer whenever required.

Pipe connections for venting, placing of concrete lining, and hydrostatic testing, lineup clips, strongbacks, supporting and anchoring devices, parts of the internal bracing, the test bulkhead, and any other articles welded to the conduit, shall be of approved weldable quality steel having a maximum carbon content of 0.30 percent.

Gaskets and protective coatings of metalwork shall be in accordance with Sections 32.17 and 32.18.

Steels, other than clad or stainless, specified in this section of the specifications, are referred to on the drawings and other sections of these specifications as carbon steel.

SECT. 32.3 Except as modified on the drawings and in these specifications, the design and construction of the metal work under Items 32, 33, and 34 shall comply with the general requirements and the requirements for electric fusion welding of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, 1959 Edition, and the latest addenda thereto, hereinafter called the Code. Bolted flanged connections shall be of the integral and of the loose types, as shown on the drawings or approved, and where not completely dimensioned on the drawings, they shall be designed in accordance with the rules of the Code. Modification of these rules, made necessary by the use of full face and rubber ring gaskets, shall be as approved. The location, dimensions, and design of Code test heads and bulkheads, and closure of openings for construction purposes and the locations for vent and concreting connections shall be submitted for approval. The working pressure in these structures, including water hammer, will be about 86 pounds per square inch.

Design and  
construction.

SECT. 32.4 The Contractor shall submit for approval the arrangement and details of shop and field longitudinal and circumferential joints he proposes to use in fabricating and erecting the steel release water conduit. Shop and field longitudinal joints shall be alternated and oriented, as approved. Details of longitudinal and circumferential joints for the clad steel pipes and stainless steel pipes shall be submitted for approval. Except where shipping clearances or stress relieving facilities place a limitation on the size of a section of the steel release water conduit which may be fabricated in the shop, all longitudinal joints shall be welded in the shop. Before approval will be given for fabricating any section of conduit in a manner requiring the welding of longitudinal joints in the field, the Contractor shall submit satisfactory evidence that the entire section cannot be stress relieved or shipped by truck or by rail without resorting to the use of longitudinal field joints.

Fabrication.

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All parts of the conduits and pipes shall be accurately cut and formed to the shapes and dimensions shown on the approved drawings. All operations of fabrication and erection shall be done in accordance with the best shop and field practice for electric welding for the type and kind of welding required and as approved by the Engineer.

The cutting of plates to size shall be by approved methods that will not injure the plates. The edges of plates shall be accurately machined, planed or milled to straight lines, true and smooth and shall be free of surface cracks, and shall be of such shapes and dimensions as to allow thorough fusion and complete penetration of the welded joints. In special cases where satisfactory evidence is submitted that it is not practicable to cut plates or prepare edges as specified above, flame cutting or other approved methods will be permitted. However, the edges to be welded shall be uniformly smooth and shall be free of all loose scale and slag accumulations before welding.

Before the plates are rolled, the edges of the plates shall be formed to the required curvature by acceptable methods. The plates shall be cold rolled, except as otherwise approved, to the required curvature which shall be continuous and uniform from edge to edge. The rolls shall be of sufficient length and of ample strength for the dimensions and thickness of the plate being rolled.

All parts shall be adjusted to an accurate fit and shall be properly marked. Structural shapes shall be bent accurately to the curves required, and the surfaces which will come in contact when fabricated shall be free from burrs and shall bear over the entire contact surfaces.

**Machining.**

All machining shall be expertly done and held strictly within the tolerances shown on the drawings. The stainless steel weld inlays on steel flanges shall be machined flush with the finished surfaces of the flanges. The faces of the flanges shall be machined to finishes specified on the drawings or as approved and shall be truly perpendicular to the axes of the pipes. Excessively heavy cuts will not be permitted; a sufficient number of cuts shall be made to avoid straining the material, and carbide tipped tools shall be used as required to avoid contamination of the finished surfaces of stainless steel. Particular attention is directed to the necessity for completing all welding, stainless steel weld inlays, and stress relieving before the faces of the flanges are machined. Except as otherwise shown on the drawings, the tolerances for the circumferences of the sections shall be plus  $3/8$  inch; minus zero, for the steel release water conduit, and plus  $1/8$  inch, minus zero, for the clad metal pipes. The out-of-roundness at any cross section, measured by the difference between the maximum and minimum diameters, shall not exceed one inch for the steel release water conduit and shall be the very minimum that can be obtained by the best workmanship for the clad steel and stainless

**Tolerances.**

steel pipes. The exterior surfaces of the plain ends of the clad steel and stainless steel pipes shall be free from indentations, projections, or roll marks in order to make a tight contact with the rubber gaskets of the pipe couplings. The alignment of finished pipe and conduit sections shall be truly straight with walls parallel to the axis of the pipe or conduit and the ends perpendicular to their axes. Faulty alignment shall not exceed 3/16 inch from a line parallel to the axis of the pipe or conduit. Completed sections shall have no reverse curvature, kinks, or injuries, and no change of curvature except as shown on the drawings.

Connections which the Contractor may require for vents, for hydrostatic testing, or for placing concrete linings and which are approved, shall be fabricated in the shop before stress relieving. All other details, as shown on the drawings or ordered, shall be carefully located and completely fabricated in the shop. All holes in the plates of the steel release water conduit may be made either by drilling or by means of burning, reaming to the proper size, and cleaning of the edges by grinding. All holes in the clad steel pipes shall be made by drilling. In order to prevent incipient corrosion, special efforts shall be made at all times to keep the stainless steel surfaces of the clad steel and the stainless steel pipes and of the various stainless steel parts from coming in contact with metals other than stainless steel. The interior of clad steel pipes shall be protected, during erection in the field and concrete lining operations, by wooden planks or other approved means.

Special  
work.

Bracing of the type shown on the drawings or of alternate design, after approval as to detail and spacing, shall be furnished and placed inside the steel release water conduit in order to maintain its roundness and prevent overstressing during fabrication, transportation, hydrostatic testing in the shop and in the field, and erection in the field. Additional approved internal bracing which may be required for supporting the weight of concrete to be placed around the conduit and pipes shall not be included for payment under Items 32, 33, or 34, but shall be considered as included in the work of Item 14. The bracing of the steel release water conduit may be attached by welding or by means of steel welding studs, as approved. The carbon content of the steel welding studs shall not exceed 0.23 percent. The studs shall be a full base, granular flux filled type equal to that made by Nelson Stud Welding Division of Gregory Industries, Inc., Lorain, Ohio. Controls, equipment, and the method for welding the studs to the steel conduit shall be as specified by the manufacturer, unless otherwise approved. The welders who apply and later remove the studs shall be qualified as specified in Section 32.7.

Bracing.

The test bulkhead for the release water conduit shall be of approved Code design. It may be attached to the conduit by welding. Removal of the bulkhead may be done by an approved flame cutting method provided

Test  
bulkhead.



the work is done by a qualified burner and provided the flame is kept far enough from the conduit so as to prevent gouging or other damage. Any damage to the conduit that may result from these operations shall be repaired by welding and grinding. After removal, the field test bulkhead shall be cut into sections that can be transported and taken out of the conduit without damage to any part of the conduit, pipes, or venturi meter.

**Descaling  
and sand-  
blasting.**

SECT. 32.5 At approved stages in the shop operations, mill scale, rust, dirt, and other foreign matter shall be removed from the metal work under Items 32, 33, and 34. After complete fabrication, including stress relieving and machining, the steel release water conduit and clad steel pipes shall be cleaned on the interior and exterior surfaces by sandblasting. Such sandblasting shall include structural steel parts and unmachined surfaces of flanges. Stainless clad surfaces shall be sandblasted with new clean sand of approved sizes. Sand used for the cleaning of the backing plates of the clad steel pipes and of steels other than stainless shall not be used on the cladding. Subsequent operations in the shop and in the field shall be so conducted, as to avoid rusting of the steel and to keep the metal surfaces free from dirt and foreign matter in order to reduce the amount of required cleaning prior to field assembly and prior to the work under other items of depositing concrete masonry around or inside the conduit and pipes. To this end, the surfaces of the metal work of the conduit and pipes, immediately after sandblasting, shall be protected by coatings, to the extent shown on the drawings and as specified in Section 32.18.

**Welding  
procedures.**

SECT. 32.6 The welding procedures shall be qualified in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding Procedures, Welders and Welding Operators, 1959 Edition, and all addenda thereto, of the American Society of Mechanical Engineers. At the earliest practicable date, the Contractor shall submit for approval complete procedure specifications with drawings for both shop and field welding work in accordance with Appendix II, QA-10, of Section IX of the Code and shall prepare test welds made in accordance with the approved procedures. The test welds shall be made, radiographed, stress relieved, and tested according to the requirements of Section IX of the Code, under the supervision of the Engineer. Test welds for the shop joints shall be made by the fabricator, and include impact tests as outlined in UG-84 of Section VIII of the Code for test plates made of materials subject to impact tests at the mill. Test welds for the field joints shall be made by the Contractor or by an agent approved as the field erector, other than the fabricator, unless the fab-

ricator is also the field erector. The Contractor shall furnish all materials and bear all expenses of qualifying the welding procedures.

SECT. 32.7 All welding shall be done by welders and welding operators who are skillful and have had proper and adequate experience in the method of welding and with the materials to be used. No welder or welding operator shall be employed who has not fully satisfied the requirements of Section IX of the ASME Boiler and Pressure Vessel Code, 1959 Edition, and all addenda thereto. Performance qualification tests of each welder and welding operator employed on the work shall be made in accordance with the requirements of Section IX of the Code under the supervision of the Engineer. Additional tests may be required as the work progresses and the Engineer may demand the removal of any welder or welding operator whose work is not satisfactory. The Contractor shall furnish all materials and bear all expenses of qualifying welders or welding operators.

Welders and  
welding  
operators.

If the Contractor elects to attach internal bracing by means of steel welding studs, the operators who apply the studs to the steel release water conduit, as specified in Section 32.4, shall be qualified to do this work in accordance with the tests recommended by the manufacturer. The qualifying tests shall be made in the presence of the manufacturer's representative, unless otherwise approved, and also under the supervision of the Engineer. If the studs are ordered to be removed, the burners shall qualify to do this work under the supervision of the Engineer. Any such work shall be done with the use of an approved torch tip and without damage to the steel release water conduit.

SECT. 32.8 All welding shall be done in accordance with the approved procedures. Shop and field joints shall be of approved design and cross section as established by the procedure tests. In the shop, all longitudinal and circumferential joints shall be welded by automatic welding machines using a submerged arc, except as otherwise approved. Semi-automatic hand welding with shielded arcs will be permitted as approved by the Engineer on special work that cannot be welded on automatic machines. In the field, all joints shall be hand welded except as the Contractor may elect to use approved automatic machines for joints adapted to such procedure. Where required by the Engineer, the sequence of welding shall be submitted for approval.

Welding.

The edges of the plates at longitudinal and circumferential joints shall be accurately matched and retained in position during the welding operation. Tack welds may be used to hold the edges in line provided the



tack welds are removed so that they do not become a part of the joint. Particular care shall be taken in matching up the edges of plates at circumferential joints to insure that all joints are properly aligned. The edges of plates when in position for welding shall be practically straight and parallel. For manually welded joints, the maximum gap between the edges shall be no more than 1/8 inch greater than the approved root opening. The maximum permissible parallel misalignment shall be 3/16 inch. Special attachments, such as lineup clips and strong backs, shall be welded by qualified welders and removed by chipping or grinding, and any remaining scars in the plate shall be welded and ground flush with the plate surface. Unless otherwise shown on the drawings, double welded butt joints shall be used for the shop and field longitudinal and circumferential joints, except where backing pieces may be used for temporarily joining sections for the shop hydrostatic tests. Any such backing pieces shall be of the same material as the base metal and shall be attached by fillet welding. Care shall be exercised in the removal of backing pieces and any damage resulting from these operations shall be repaired by welding and grinding. All welds shall be made in such a manner as to have minimum residual stresses in the welds after cooling and to insure uniform distribution of the load throughout the welded sections with no tendency to produce eccentric loading or shear in the weld or the metal adjacent thereto.

Welding shall not be performed when the temperature of the base metal is less than ten degrees Fahrenheit or when the surfaces to be welded are wet from rain, snow, or ice. Unless the operator and the work are protected in an approved manner, no welding shall be done during periods of high wind. At temperatures between ten and 40 degrees Fahrenheit, the base metal for a minimum distance of three inches on each side of the weld groove shall be preheated to a minimum temperature of 150 degrees Fahrenheit before the welding is started. Preheating shall be continued around the joint to the extent necessary to maintain the required temperature.

The Contractor shall provide adequate ventilation during welding operations, shall provide proper storage of electrodes to prevent moisture in their coating, and shall maintain the welding machines and their ammeters and voltmeters in first class working condition in order to secure good welding. Both surfaces of steel plates that are to be joined by automatic welding machines shall be ground to clean metal for a distance of one inch on each side of such joints prior to welding. Undercutting or sharp shoulders along the sides of the finished welds will not be permitted. If welding is interrupted for any reason, special care shall be taken, when welding is resumed, to get full penetration and thorough fusion between the weld metal and the plates and the weld metal pre-

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viously deposited, chipping being done as required. All slag and scale shall be removed from each deposited layer of welded metal before additional weld metal is applied to its surface.

All butt welds, except when produced with the aid of backing plates, shall have the root of the initial weld gouged, chipped, or otherwise removed to sound metal before welding is started from the second side. No weld or other metal, except as shown on the approved drawings, shall project more than 1/16 inch from the plates into the finished carbon or stainless steel pipe. The welds shall be built up uniformly from the surface of the plate to a maximum at the center of the weld, not exceeding 3/32 inch on the outside and 1/16 inch on the inside of the pipe. Particular attention is called, however, to the importance of the requirement that there shall be no valley, groove, or sharp shoulder along the edge or in the center of the weld, but that the deposited metal shall be fused smoothly and uniformly into the plate surface, and the finish of the welded joints shall be reasonably smooth and free from irregularities, grooves, or depressions. The interior and exterior surfaces of the welded joints within the critical zones of the manifold designated on the drawings shall be ground and repaired by welding as necessary to obtain smooth welded joints that blend into the adjacent plate surfaces. Weld reinforcements on the inside of clad steel pipes shall be removed flush with the surface of the plate. Stainless steel and stainless steel welds shall be protected from contamination by carbon steel and shall be cleaned with stainless steel wool, stainless steel brushes, or other approved means.

After all field welding has been completed, the heat affected zones at the joints shall be cleaned to bare metal and recoated in accordance with the requirements of Section 32.18. The interior and exterior coatings of the steel pipe and conduit shall be maintained in first class condition by touching up or by recoating, as required, until the concrete masonry has been placed.

SECT. 32.9 Welds of the metal work under Items 32, 33, and 34 shall be subjected to examination for defects by the Contractor and/or by The City to the extent and as indicated by the symbols and notes on the drawings and in accordance with these specifications. Except as otherwise noted on the drawings, the stainless steel pipes 12 inches in diameter or larger shall be radiographed to the extent shown on the drawing. Stainless steel pipes smaller than 12 inches in diameter will not require radiographic examination.

Weld examinations.

The preparation of the shop and field welds for radiographic examination, the radiography, the interpretation of the radiographs, and the repair of defects shall be in accordance with the rules of Paragraphs UW-51

Radiographic examination.



and UW-52, Section VIII, of the ASME Boiler and Pressure Vessel Code, 1959 Edition, and as approved by the Engineer, except for spot radiographs. The minimum extent of spot radiographic examination shall be one spot examination on each circumferential weld and one spot examination on each longitudinal weld between two successive circumferential welds. The minimum length of spot examination shall be 12 inches and the porosity shall be treated in the same manner as required by the Code for complete radiographic examination. All radiographic examination in the shop shall be done by the Contractor. The radiographic examination in the field will be performed by and at the expense of The City, and is not included as part of the work under Item 32. At such times as ordered by the Engineer, the Contractor shall prepare designated field welded joints for radiographic examination, provide a clean, dry, sheltered, and unencumbered working space around each such joint and then cease all operations in the vicinity of these joints. He shall lend all assistance necessary for authorized personnel to gain safe access to the various portions of the joints to be radiographed and, during exposure of the joints to radiographic examination, shall post watchmen and erect wooden barricades, as ordered, to keep the area clear of unauthorized persons. The Contractor shall assign a qualified welder to promptly make the repairs required as a result of the radiographic examination of the original welds and any repair welding. All repair weld areas shall be reexamined radiographically and shall comply with the requirements of Paragraph UW-51 (m) of the Code. Except for ordered wooden barricades, no direct payment will be made to the Contractor for any necessary repair welding, for any delays in the work caused by the radiographic examination of the field joints by The City or for the cost of any labor, materials, equipment, and services that may be required to be furnished by the Contractor to permit The City to do the field radiographing specified herein, but the cost thereof shall be considered as having been included in the price stipulated for Item 32.

**Penetrant  
examination.**

Where shown on the drawings or ordered, stainless steel welds shall be examined by the liquid penetrant method made in accordance with the appropriate requirements of the Military Standard MIL. STD. 271A (Ships) dated 2 January 1959, of the Department of Defense. Defects shall be removed and the areas repaired and reexamined as specified above.

**Magnetic  
particle  
examination.**

Where shown on the drawings or ordered, certain welds shall be examined by the dry powder magnetic particle method in accordance with the requirements of the Tentative Method for Dry Powder Magnetic Particle Inspection, ASTM Designation: E109-57T, of the American Society for Testing Materials.

Shop radiographic, penetrant, and magnetic particle examinations and their interpretations will be done by the Contractor. Field radiographic and magnetic particle examinations and their interpretations will be done by

The City. All interpretations of shop examinations will be reviewed by the Engineer.

All defects that are disclosed by the shop and field examinations shall be satisfactorily repaired by the Contractor to the extent ordered and shall be reexamined.

The Contractor shall supply electric energy and light required for the magnetic particle examinations to be made in the field.

SECT. 32.10 The shop welded joints of the release water conduit and clad steel pipes, after being examined in accordance with Section 32.9 and any defects repaired, shall be stress relieved according to the rules of Paragraph UW-40 of the Code. Stress relieving in the shop shall be done by heating each completely fabricated section in an oven, as approved. Stress relieving of field joints will not be required.

Stress  
relieving.

SECT. 32.11 The sequence of operations in the shop and in the field in welding and erecting the release water conduit shall be such that when any two sections are joined by welding, one of the sections shall be supported on rollers or lubricated plates in an approved manner to minimize restraint. If the inspection of root passes of these welds reveals cracks, the supports of the free end shall be modified to the extent required to prevent the formation of these root pass cracks.

Elimination  
of restraint  
during welding  
of release  
water conduit.

SECT. 32.12 The steel release water conduit and the clad steel and stainless steel pipes shall be subjected to hydrostatic tests up to 130 pounds per square inch pressure, as hereinafter specified. The hydrostatic tests shall not be conducted when the temperature of the air, the water, or the metal in the conduit or pipes is less than 40 degrees Fahrenheit. Hydrostatic tests in the shop shall be performed with gaskets of the kind shown on the drawings and meeting the requirements of Section 32.17. For the shop and field tests, the pressure shall be applied gradually and maintained, at stages of 45, 90, and 130 pounds per square inch, until all welded, bolted, and coupled joints have been thoroughly inspected. All defects shall be acceptably repaired and the tests repeated as ordered.

Hydrostatic  
testing.

Hydrostatic tests shall be made in the shop on the steel release water conduit manifold and the clad steel and stainless steel release water pipes. The flanged sections of the pipes may be connected together for purposes of the test.

During the shop hydrostatic tests of the release water pipes the sleeve type and segmental type couplings furnished under Item 43 shall



be in place. Sections of pipes, connected by the sleeve type couplings, shall be arranged during the tests with a gap of approximately one inch between the plain ends of the pipes, and the sections shall be adequately braced at the ends to withstand the end thrust of the pipes due to the hydrostatic pressure.

After shop hydrostatic tests have been completed, if shipping requirements make it necessary to cut the manifold apart into smaller sections, the cuts shall be made at approved locations and the joints, resulting from such cuts, shall be fully prepared in the shop for subsequent field welding. Cuts will not be permitted at existing joints.

Hydrostatic tests shall be made in the field on the release water conduit and all pipes furnished and placed under Items 32, 33, and 34. The test of the release water conduit shall be made after it is in final position but before concrete masonry is placed around or within it.

As required or approved, sections of the release water pipes shall be individually hydrostatically tested before concrete masonry is placed around them. The tests on the remaining portions of the release water pipes shall be conducted with couplings, valves, anchorages, and the 24-inch by 18-inch venturi meter in final position.

An approved Code steel bulkhead for testing shall be placed in the adjoining section of the release water conduit which was placed under another contract and, if required, shall be provided with an access manhole. If the bulkhead is to be welded directly to the release water conduit, it shall be fabricated from steel complying with Section 32.2. Removal or the bulkhead shall be in the manner stated in Section 32.4.

One 24-, one 54-, one 60-, and one 72-inch blind flanges are to be furnished by the Contractor under Item 32 and stored in the release water chamber. These blind flanges and all others to be furnished and permanently placed in the work under Item 32, may be used for purposes of the shop and field hydrostatic tests. After tests are completed, any damage to the metal and protective coatings shall be satisfactorily repaired. Before being stored in the release water chamber, the unfinished surfaces of the blind flanges shall be given an additional coat of "Tarsol-Thin", or approved equal, in accordance with Section 32.18 and all other surfaces, including the bolt holes, shall be coated with "1977 Texaco Rustproof Compound L", as manufactured by Texaco, Incorporated, New York, N.Y., or approved equal, applied at the rate of one gallon per 25 square feet. Under Item 32, the Contractor shall furnish all approved temporary test heads, bulkhead, threaded fasteners, bracing, and supports. Gaskets, water, hydraulic pumps, electricity, pressure gages, electric strain gages, instruments, labor, and other materials and equipment required to satisfactorily complete the tests, will be considered as included in the prices

of Items 32, 33, and 34. To avoid possible damage to the flanges, no temporary test heads or blind flanges may be used or reused unless approved by the Engineer.

As part of the work of the hydrostatic tests in the shop, tests shall be conducted by the Contractor to determine the stresses developed in the critical zones of the manifold while under pressures in steps of 45, 90, and 130 pounds per square inch. Strain measurements shall be taken by strain gages placed inside and outside the manifold at locations determined by the Engineer. The gages shall be SR-4 strain gages manufactured by the Electronics and Instrumentation Division of the Baldwin-Lima-Hamilton Corporation, Waltham, Massachusetts, or approved equal. The Contractor shall furnish and install 300 gages, one-element, two-element, and three-element, as ordered, containing a total of 500 strain elements, and in addition he shall provide the required number of dummy gages needed for temperature effect corrections, and the necessary electrical instruments for switching and measuring the strains. Dummy gages shall be applied to pieces of the plate used for the fabrication of the manifold. These plates and gages shall be mounted on the manifold so as to maintain the same temperature as that existing in the walls of the manifold. A number of strain gages shall be located inside the manifold, as directed by the Engineer, and the waterproofed strain gage wires shall be passed through an approved watertight gland to the electrical instruments. The preparation and cleaning of the surfaces of the manifold, the application, moistureproofing, and testing of the strain gages, and the reading of the strain gage instruments shall be done in accordance with the recommendations of the manufacturer, under the supervision of the manufacturer's representative, and in the presence of the Engineer.

Stress determinations.

Prior to the shop hydrostatic test the Contractor shall prepare and test specimens of the actual steels used in the fabrication of the critical zones of the manifold designated on the drawings including the carbon steel and the stainless clad plate to determine the true stress-strain curve, Young's Modulus, and Poisson's Ratio. The Contractor shall provide at least two test specimens from each of the plates to be tested. The determinations of Young's Modulus and Poisson's Ratio shall be made in accordance with the Tentative Method for Determination of Young's Modulus at Room Temperature, ASTM Designation: E111-59T, and the Tentative Method for Determination of Poisson's Ratio at Room Temperature, ASTM Designation: E132-58T, except that approved SR-4 strain gages shall be used instead of extensometers. The stress-strain curve shall be obtained by means of an autographic strain recorder. The test specimens shall be subjected to the same heat treatment as the manifold. These tests shall be made on an approved testing machine which has been calibrated just prior to the tests and the tests shall be witnessed by the Engineer. The results of these



tests shall be submitted to the Engineer at least two weeks prior to the start of the shop hydrostatic test.

The instruments used for switching and strain measurements shall be especially designed for use with SR-4 strain gages and shall be equal to those manufactured by the Baldwin-Lima-Hamilton Corporation. Areas on the manifold near the branch connections shall be thoroughly cleaned of all oil, grease, and dirt to the satisfaction of the Engineer. These areas shall be given a coat of white Portland cement, lime, or other approved material for the purpose of visibly indicating areas of stress concentration during the hydrostatic tests. Strain measurements shall be taken and recorded for all strain gage elements at each of the three pressure steps of 45, 90, and 130 pounds per square inch. After reducing the pressure to zero, the above procedure of making the strain measurements shall be repeated. Before the strain measurements are repeated, all strain gage elements shall be checked to determine that zero strains exist. Twelve photographs, 8½ inches by 11 inches in size, of the shop tests on the manifold shall be taken as directed and incorporated in a report describing the equipment used in the test and the method of testing, and containing tabulations of recorded and computed test data. The Contractor shall submit the report in quadruplicate together with the negatives of the photographs which shall become the property of the Board.

For all hydrostatic tests, at least two high quality pressure gages shall be used for determining the test pressures. The pressure gages shall be tested and calibrated just prior to and immediately after completion of the shop and field hydrostatic tests. The testing and calibrating of the gages shall be done in the presence of the Engineer or certified to by an approved testing laboratory.

Submission of  
fabrication,  
erection, and  
testing  
procedure.

SECT. 32.13 The Contractor shall submit in full detail, for approval by the Engineer, the proposed method and sequence of operations for the fabrication and erection of all the work under Items 32, 33, and 34 and the hydrostatic testing as specified in Section 32.12. Before commencing any fabrication, the Contractor shall obtain approval by the Engineer of shop drawings.

In preparing the field erection and testing procedure, attention is directed to the fact that the 143-inch by 102-inch venturi castings and cones, furnished by The City and installed under Item 39, must be placed within the venturi enlargement section of the release water conduit during the erection of that conduit. After field hydrostatic tests have been completed, the castings and cones shall be accurately positioned and holes trepanned through the conduit for the installation of vent, piezometer, and drain connections for the venturi meter.

The Contractor shall obtain approval by the Engineer of testing procedures, materials, instruments, equipment, and details, prior to the commencement of the hydrostatic tests in the shop. Shipment of the metal work under Items 32, 33, and 34 shall not be made before the Engineer has approved all details of erection and of the hydrostatic tests to be made in the field.

SECT. 32.14 The stainless steel orifice plates, the venturi meters, and valves furnished by The City for installation under Item 39, and the release water conduit, clad steel and stainless steel pipes shall be installed as shown on the drawings. Sections of the release water pipes adjoining the valves and the 24-inch by 18-inch venturi meter shall not be fabricated until the Contractor is given the flange to flange lengths of the valves and venturi meter by The City. The Contractor will be held fully responsible for accurately placing the parts of the release water conduit and release water pipes that are to be bolted to the venturi meter and valves. These parts shall be in correct position, with axes in proper alignment and with flanges parallel so that setting of the venturi meter and valves can be accomplished without the use of filler plates, tapered spacers, or other devices. After aligning the waterway surfaces at the joints, in the field, flanges at the 24-inch by 18-inch venturi meter, as indicated on the drawings, shall be fitted with four No. 10 taper pins each, unequally spaced around the flanges. The taper pins shall be machined from the same grade of stainless steel as the bolts furnished under Item 34 and shall be paid for under that item.

Assembly and alignment in the field.

SECT. 32.15 As shown on the drawings, stainless steel washers and threaded fasteners, such as screws, bolts, studs, and nuts, shall be furnished and installed in the work under Item 34 for all stainless steel flanged joints, for the manhole covers, for the 78-inch blind flange, for the exposed carbon steel flanged joints of the pipes, for bolts of anchoring devices used for fastening the supports of the aluminum gratings, and for other purposes shown on the drawings or ordered.

Stainless steel threaded fasteners and washer.

As shown on the drawings, carbon steel threaded fasteners shall be furnished and placed for carbon steel flanged joints which are to be embedded in concrete masonry; shall be furnished, prepared for storage, and stored with ordered blind flanges in the release water chamber; shall be furnished, as approved, for use during the hydrostatic tests on the conduit and pipes; and shall remain the property of The City.

Carbon steel threaded fasteners.

Bolts, studs, and nuts will be provided with the valves which will be furnished by The City and shall be placed under Item 39. Bolts and nuts



for pipe couplings, furnished under Item 43, will be furnished and placed under that item.

**Taper pins.**

Taper pins shall be furnished and placed under Item 34 in the flanges of the 24-inch by 18-inch venturi meter and the adjoining pipe flanges to maintain accurate alignment of the waterway surfaces.

**Stainless steel threaded fasteners.**

Stainless steel for screws, bolts, studs, and taper pins shall comply with the requirements of the Tentative Specifications for Alloy-Steel Bolt- ing Materials for High-Temperature Service, ASTM Designation: A193-59T, Grade B8F, of the American Society for Testing Materials. Stainless steel for nuts and washers shall comply with applicable requirements of the Tentative Specifications for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, ASTM Designation: A194-59T, Grade 6, of the American Society for Testing Materials.

**Carbon steel bolts, studs, and nuts.**

Carbon steel for bolts, studs, and nuts shall comply with the requirements of the Tentative Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners, ASTM Designation: A307-58T, Grade B, of the American Society for Testing Materials.

One tension test shall be made for each lot of 100 screws, bolts, or studs, or fraction thereof, of each size.

**Bolt heads and nuts.**

All bolt heads and nuts shall be semi-finished, hexagonal in shape, and in accordance with the dimensions of the Regular Series of the American Standard Specifications for Square and Hexagon Bolts and Nuts (ASA B18.2-1955), unless otherwise shown on the drawings or approved.

Threads shall be in accordance with American Standard Specifications for Unified Threads (ASA B1.1-1960), Coarse Screw Threads, Class 2A and 2B, carefully threaded so as not to injure the material and so as to produce smooth, clean threads. The ends of studs which screw into tapped holes shall be a wrench-tight fit. Sizes 1-1/8 inches and larger shall conform to the American Standard 8-Pitch Thread Series. In order to insure correct fit of threads, the nuts shall be screwed on in the shop to all bolts and studs of the kind herein specified, and the articles shall be shipped thus assembled and prepared for shipment in compliance with the requirements of Section 32.20. Bolts and nuts used solely for making shop and field tests will be included for payment under Item 32; such bolts and nuts shall be of an approved carbon steel. Bolts and nuts used for shop or field tests shall be included for payment only once. Bolts, studs, or nuts which will ultimately be placed in the work or stored in the release water chamber may be used in the shop and field tests, but if they are damaged during their use in the tests they shall be replaced at no additional cost to The City.

**Insulating sleeves and washers.**

The Contractor shall furnish and place insulating sleeves and washers on stainless steel threaded fasteners, as called for on the drawings, which

contact dissimilar metals such as the stainless steel parts of anchoring devices for the aluminum gratings in the release water chamber. These sleeves and washers shall be bakelite, as manufactured by F. H. Maloney Company, Houston, Texas, or approved equal.

SECT. 32.16 Holes for bolts in flanges shall be drilled larger than the body size of the bolts as follows: 1/8 inch larger for bolts under 1½ inches in size, 3/16 inch larger for 1½-inch bolts and ¼ inch larger for bolts 1½ inches and over in size. All bolt holes shall be spot faced. Where flanges come thicker than the designed dimensions, the spot facing shall be carried to such a depth as is necessary to insure the proper bearing for bolt heads and nuts and to give the desired grip. Back facing of flanges will not be permitted as a substitute for spot facing. All bolt holes shall be in true alignment with the bolt circles centered on the axes of the pipes and the axes of the bolt holes shall be truly perpendicular to the faces of the flanges. The edges of the holes for the taper pins shall be chamfered to facilitate the entrance of the pins. Bolt holes.

SECT. 32.17 Unless otherwise shown on the drawings or ordered, the joints of flanged pipes 24-inches in diameter or smaller shall be made up with "Vellumoid", full face paper gaskets 1/32 inch thick, as manufactured by the Vellumoid Company, Worcester, Massachusetts, or approved equal. Gaskets.

With the exception of the 78-inch flange at the end of the release water conduit manifold, whose joint will be made up with a "Vellumoid", or approved equal gasket, all joints of flanged pipes larger than 24-inches in diameter and the 18-inch manhole shall be made up with round, rubber ring gaskets as shown on the drawings. The rubber shall be of a composition and texture to assure a watertight and permanent seal and shall be, in all respects, the equal of extruded rubber cord made by the Goodyear Rubber Company, New York, N.Y. The gaskets shall be circular in cross section, of the sizes shown on the drawings. The ends of the gaskets shall be bevelled and vulcanized in an approved manner, to form continuous rings of the required diameters. The surfaces of the rubber gaskets shall be smooth, free from pits, blisters, pores, cracks, and other imperfections. Rubber for the gaskets shall meet the following physical requirements when tested in accordance with appropriate sections of Federal Test Method Standard, Rubber: Sampling and Testing (Federal Test Method Standard No. 601, dated April 12, 1955). The rubber compound shall consist of first grade natural crude rubber and suitable pulverized fillers. The tensile strength shall be at least 3,000 pounds per square inch. The elongation at rupture shall be such that 2 inch gage marks shall



stretch to not less than 10½ inches. The specific gravity shall be between 1.16 and 1.22. The percent of cold flow, computed as 100 times the change in thickness divided by the original thickness, shall not exceed 10 percent. The change in thickness is produced by subjecting a disc of the material 1/4-inch thick by 3/4 inch in diameter to a pressure of 600 pounds per square inch using a spring pressure device placed in an air oven at a temperature of 158 degrees Fahrenheit for 24 hours. The measurement shall be made thirty minutes after the specimen has been removed from the loading device. The tensile strength of the compound after being subjected to an accelerated aging test for 96 hours in air at 158 degrees Fahrenheit shall not be less than 80 percent of the tensile strength before aging. The Durometer hardness, shore "A", shall be 65 plus or minus 5. Certified copies of reports of the properties of the rubber gaskets shall be furnished and, if directed, samples of the rubber to be used in the work shall be furnished, delivered at designated points, and tested in the presence of the Engineer, at the expense of the Contractor. Rubber gaskets which will ultimately be placed in the work may be used in the shop and field test but if they are damaged during their use in the tests they shall be replaced at no additional cost to The City. Gaskets required for pipe couplings shall be furnished and placed under Item 43.

**Protective  
coatings.**

SECT. 32.18 Prior to the application of any protective coatings, all metal surfaces shall be cleaned and prepared in accordance with Section 32.5.

**Coal tar  
epoxy-resin  
coatings.**

Where shown on the drawings or ordered, pipes, flanges, and manhole covers shall be given a minimum of three coats of an approved coal tar epoxy-resin, having a finished thickness of not less than 16 mils, equal to "Tarsset-Thin", made by the Protective Coatings Division of Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania. In general, unless otherwise ordered, these surfaces will consist of the exterior surfaces of the clad steel release water pipes to the extent shown on the drawings, exposed surfaces of carbon steel flanges, both faces of all blind flanges and manhole covers with the exception of machined areas and all surfaces of the release water pipe intake screen located within the manifold. The "Tarsset-Thin" or its approved equal shall be applied strictly in accordance with the manufacturer's instructions by approved coating applicators. Unless otherwise approved, the coatings shall be applied in the shop. After the pipes, flanges, or screen have been installed in the work, any damage to the coatings shall be repaired by cleaning the area and recoating with "Tarsset-Thin" or approved equal. The surface temperature of the metal being coated shall be above 50 degrees Fahrenheit during the application of all coatings in the shop or in the field. Coatings shall not be applied on damp surfaces or during rainy weather.

Where the coatings of "Tarsset-Thin", or approved equal, will be in direct contact with the water such as those applied to the release water pipe intake screen and interiors of manhole covers and blind flanges, each applied coat shall be thoroughly dried by heating with infra-red lamps or by other approved means to a temperature of about 200 degrees Fahrenheit.

All carbon steel surfaces of the release water conduit and the release water pipes, which do not require coatings of "Tarsset-Thin", or approved equal, in accordance with the drawings, and against which concrete linings or envelopes will be placed, shall be given a heavy coat of boiled linseed oil. This coating shall be renewed, as required, to prevent rusting.

Boiled  
linseed oil.

The housings for the vent and drain connections for the 143-inch by 102-inch venturi meter shall be filled with a bitumastic material as called for on the drawings. This material shall be the approved equal of Pitt Chem 101 as manufactured by Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania.

The machined surfaces of flanges shall be coated with "1977 Texaco Rustproof Compound L" and all threaded fasteners of carbon steel or Type 400 series stainless steel shall be slushed with approved slushing grease or oil.

Machined  
surfaces.

SECT. 32.19 Stainless steel marking plates shall be seal welded to the outside of the flanged sections of the release water pipes and to the blind flanges as shown on the drawings. There shall be stencilled upon each marking plate, with 1/4-inch numerals, the test pressure, the date when shop tested, the mark number shown on the drawings, and the weight of the piece. Each marking plate shall also provide a place for the inspector's stamp and, where shown on the drawings, shall be stencilled with an arrow indicating the direction of flow.

Marking  
plates.

SECT. 32.20 Preparation for shipment shall be as directed or approved. All small parts shall be strongly boxed and coated or finished surfaces shall be protected. Threaded fasteners which are to be incorporated in the work, stored in the release water chamber, or used for testing shall not be used for any bolting required for shipment. The finished surfaces of all the exposed flanges shall be protected by wooden flanges strongly built and securely bolted to the flanges they protect. Threaded fasteners of carbon steel or Type 400 Series stainless steel shall be boxed and slushed with slushing grease or oil in accordance with Section 32.18. Shipping sections of the release water conduit shall be braced internally and adequately blocked on the railroad cars or trucks in an approved manner so as to prevent deformation or distortion of the plate. Be-

Preparation  
for shipment.



**Weights.**

fore shipment, to guard against damage by freezing, care shall be taken to protect all parts from the entrance of water. When ready for shipment, each section of conduit or pipe shall have been plainly marked with paint to show its net weight, and each box or other package shall be plainly marked to show its contents and the net weight thereof. Unless otherwise approved, articles that are to be transported from one place of manufacture to another shall be prepared from shipment and as adequately protected as for shipment for final delivery.

**Shipment between places of manufacture.****Testing and weighing in presence of Engineer.**

Testing of all kinds and scale weighing approved under these items shall, unless otherwise specifically directed, be done in the presence of the Engineer. All appurtenances, equipment, tools, and services necessary for the various specified tests, scales and assistance for weighing, and assistance for measuring any of the materials shall be furnished by the Contractor.

**Measurement and payment.**

SECT. 32.21 The quantities to be paid for under Items 32, 33, and 34 shall be the computed net number of pounds of steel release water conduit, clad steel pipes, and stainless steel pipes and other articles of stainless steel, respectively, in accordance with the descriptions for such work stipulated in Section 32.1, that are furnished, tested and incorporated in the work or stored in the release water chamber in accordance with the contract drawings and approved shop drawings or as ordered, computed from the sizes and dimensions of the materials shown on the approved shop drawings. The unit weights of all steels furnished under Item 32 shall be based on 0.2833 pound per cubic inch; under Item 33 shall be based on 0.2839 pound per cubic inch; under Item 34 shall be based on 0.2871 pound per cubic inch for chromium-nickel stainless steel alloys, and 0.2811 pound per cubic inch for straight chromium stainless steel alloys.

For certain articles such as threaded fasteners, washers, taper pins, commercially purchased small flanges, fittings and pipes less than 12 inches in nominal waterway diameter, the number of pounds may be determined, if approved by the Engineer, by weighing the articles in the presence of the Engineer. In computing the net number of pounds of structural steel under Item 32, the weights shall be based on the weights given in the latest issue of the Steel Construction Manual of the American Institute of Steel Construction and on the net dimensions of the materials furnished and incorporated in the work. In computing the net weights of the metals from the dimensions on the drawings, no deductions or additions shall be made for the loss, replacement, or addition of metals due to the following: permissible over-run or under-run in weight, openings in the release water conduit or release water pipes under 12 inches in the largest

capacities, ceiling U-bolt and eyebolt loading capacities, and other warnings, as ordered. The legends for these signs will be shown on working drawings to be issued. The signs shall have letters 1/2-inch high and shall be drilled for fastening to the masonry by means of 12 gage flat head, anchoring type, monel metal boat nails, one inch long, with rubber washers placed under the heads of the nails. The nails shall be "Anchor-fast", as manufactured by the Independent Nail and Packing Company, Bridgewater, Massachusetts, or approved equal.

SECT. 45.6 Surfaces of painted articles furnished under this item, which have become damaged or otherwise unacceptable, shall be repainted, as ordered, with approved paints. Painting and protective coatings.

With the exception of machined surfaces, the exteriors of all steel, cast iron, or semi-steel valves, and all extension stems shall be given three coats of coal tar epoxy-resin. The interiors of these valves shall be lined in a similar manner, and to the extent directed by the Engineer. All coatings and linings shall be applied to lubricated plug valves before any grease has been added. The minimum thickness of coatings and linings, the quality of materials, surface preparation, and the manner of application shall be in accordance with the requirements of Section 32.18.

SECT. 45.7 Where called for on the drawings, paper gaskets, required for making up joints between valves and pipes, shall be "Vellumoid", full face paper gaskets 1/32 inch thick, as manufactured by the Vellumoid Company, Worcester, Massachusetts, or approved equal. The paper gaskets shall be furnished and installed under Items 32, 34, 35, or 37, as appropriate. Paper gaskets.

Where called for on the drawings, dissimilar metals of flanges of valves and flanges of pipes and their threaded fasteners shall be insulated from one another, for cathodic protection, by means of neoprene-faced bakelite central gaskets for the flanges and bakelite sleeves and gaskets for the bolts. A stainless steel washer shall be installed between both the head of the bolt and the nut, and the bakelite gasket. The flange insulation shall be Type "E" flange insulation, as manufactured by the F.H. Maloney Company, Houston, Texas, or approved equal. Cathodic protection.

SECT. 45.8 After installation, all equipment furnished under this item shall be tested by the Contractor, as directed, to demonstrate to the satisfaction of the Engineer that it is working properly. Any defects in this equipment or in the installation of this equipment, disclosed by the tests, shall be corrected by the Contractor without any other compensation than that stipulated under this item. Testing.



**Valves.**

Valves shall be adjusted for smoothness of operation, tested hydraulically while installed in the pipe line, at a minimum test water pressure of 130 pounds per square inch, and adjusted as required for tightness. Any defective valves shall be repaired, in an approved manner, or replaced. After repairs or replacements have been made, the valves shall be retested in the pipe line.

**Sump pumps.**

The Contractor shall test the sump pumps to demonstrate that they are performing as specified. Instruments required to make these tests, such as pressure gages and a water meter, shall be as approved by the Engineer, and shall be calibrated before and after the tests. A certificate of calibration by an approved testing laboratory will be acceptable.

**Water sterilizer.**

The Contractor shall demonstrate that the ultra violet ray water sterilizer, and all its appurtenances, are performing as specified. Bacteriological examinations of the raw and treated water will be made by The City.

**Payment.**

SECT. 45.9 For all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to furnish, install, test, and place in readiness for operation, the articles of miscellaneous equipment of the kinds and quality specified and in the manner herein set forth, the Contractor shall receive the lump sum stipulated for Item 45.

**PUMPING****ITEM 46****Work included.**

SECT. 46.1 Under Item 46 the Contractor shall furnish, install, and maintain the necessary pumping equipment, piping, and appurtenances and shall pump water from the excavations for the contract structures and from other areas used or occupied by the Contractor, as ordered or approved; shall convey the pumped water to the existing pumpage treatment plant shown on the contract drawings or to such additional pumpage treatment plants as may be ordered or approved; shall furnish power for pumping; shall keep the excavations free from water during construction; and shall do all other work not specifically covered under other items, necessary to collect, pump, and dispose of the water in a satisfactory manner and in accordance with the requirements of Section 34. As a part of the work to be done under this item, he shall also pump and do all other work necessary to unwater the release water works and the stream control works as may be required in connection with the work of this contract. The pumpage from the unwatering of these structures may be discharged into the West

Branch of the Delaware River or be conveyed to the pumpage treatment plant, as ordered or approved. The Contractor shall submit to the Engineer for approval descriptions and drawings of the pumping equipment and piping he proposes to use. The alignment and grades of the discharge piping shall be as ordered or approved. At the completion of the work, all pumping equipment and piping, including the pump discharge pipe line to the existing pumpage treatment plant, shall be removed, and shall become the property of the Contractor.

SECT. 46.2 The Contractor shall have on hand at all times sufficient equipment and piping for all ordinary emergencies. All equipment and piping shall be maintained in good working order. All pumping operations and the supply of power to the pumps shall be at all times under the direct charge of competent mechanics.

Adequate  
plant and  
competent  
mechanics.

SECT. 46.3 All necessary provisions shall be made for limiting the quantity of water to be pumped, as the Engineer shall determine, which shall appear at any juncture to be in the best interest of The City. Surface and ground waters shall be intercepted and diverted before entering the excavations or contract structures. Dikes, ditches, or other devices, if required, shall be constructed to prevent such inflows. Whenever practicable, water bearing seams or broken ground in rock excavations, which give evidence of yielding any considerable quantity of water, shall be grouted, as ordered, under Item 23.

Provisions  
for reducing  
pumping.

SECT. 46.4 For all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified, the Contractor shall receive the lump sum stipulated for Item 46. Ordered or approved plants, in addition to the existing plant, required in accordance with Section 34 for the treatment of pumpage and drainage shall be constructed by the Contractor under the items of the contract in so far as they are appropriate and applicable.

Payment.

## STREAM CONTROL AND PLUGGING OF DIVERSION CONDUIT

### ITEM 47

SECT. 47.1 Under Item 47 the Contractor shall furnish all labor, equipment, and materials for, and shall build, maintain, and remove, as required, all structures and facilities necessary to control the waters of

Work  
included.



the West Branch of the Delaware River, divert them into the diversion conduit, and prevent them from interfering with the safe construction of the dam and other structures to be built under Contract 465. Also under this item and at such times as designated by the Engineer, the Contractor shall assume responsibility for and thereafter maintain the temporary and permanent stream control structures to be built under Contract 460; and shall modify the temporary stream control structures or portions thereof as required for use under Contract 465. As part of the work under this item, the Contractor shall maintain the river channel, and its banks, at least at its present widths until the river flow has been diverted into the diversion conduit; remove all debris and deposits obstructing flow in the river; and prevent accumulations of such materials at the supports of the bridges.

Such portions of the temporary stream control structures built under this item which are not permitted to be included as parts of the embankments and fills shall be removed and disposed of under this item, as approved and at such times as they are no longer required. Also under this item the Contractor shall, when and as ordered or approved, install the permanent stop logs, and furnish and install the temporary stop shutters in the inlet structure of the diversion conduit and make them watertight; unwater the diversion and release water conduits and the stilling basin as required, remove all debris from these structures, and keep them unwatered; control the flow through the temporary release water piping; and remove the temporary stop shutters when the plug in the diversion conduit has been placed, the release water works including the emergency gate tower are ready for operation, and the temporary release water piping and the 12-inch pipe through the plug have been filled with concrete or grout.

Such portions of the temporary stream control structures built under Item 47 and permitted to be included in the embankments or fills, removal as ordered of portions of the temporary stream control structures built under Contract 460, furnishing of the permanent stop logs, constructing the concrete plug in the diversion conduit, and filling the temporary release water pipe and the 12-inch pipe through the plug with concrete or grout will be included under appropriate items of Contract 465; but any additional costs of such work or in connection therewith shall be considered as having been included in the price stipulated for this item.

All work under this item shall be done in accordance with the limitations on diverting and impounding river flows as set forth in the Information for Bidders and in accordance with the schedule of operations submitted by the Contractor and approved by the Engineer in accordance with the provisions of Article VI of the contract.

Approval  
of stream  
control and  
plugging.

SECT. 47.2 The Contractor shall submit for approval the schemes he proposes to follow in providing stream control and in plugging the diversion

conduit and the temporary release water piping, together with detailed drawings therefor. None of this work shall be started until approved by the Engineer but such approval shall not relieve the Contractor of his responsibility for the successful completion of all work under this contract. The Contractor shall not divert the river flow through the stream control works nor do any plugging of the diversion conduit or temporary release water piping until written orders therefor are given by the Engineer.

SECT. 47.3 The area of the watershed of the West Branch of the Delaware River above the dam site is about 450 square miles. A stream gaging station at Stilesville, about 1.5 miles downstream from the dam site, has a drainage area of 456 square miles and records for this station have been kept for about seven years. A stream gaging station at Hale Eddy, about seven miles further downstream, has a drainage area of 593 square miles and records for this station have been kept for about 47 years. The maximum peak flood flow during the record period at Hale Eddy is 28,900 cubic feet per second. Attention is called, however, to a statement appearing on page 178 of Geological Survey Water-Supply Paper 1382 of the United States Department of the Interior reading as follows: "Maximum discharge known, about 46,000 cfs Oct. 10, 1903 (gage height, 20.3 ft, from floodmarks)." Yearly maximum peaks at Hale Eddy, exceeding 20,000 cubic feet per second, have occurred 13 times during the period of record. Peak flows exceeding 5,000 cubic feet per second may be expected every year at the dam site. The estimated capacity of the stream control works is shown on Sheet 40 of the contract drawings. It is to be noted that the capacity of the stream control works will not be adequate for the diversion of flood flows from the site of the dam without temporary impounding of portions of the flows.

Flood flows.

SECT. 47.4 The Contractor shall be responsible for the adequacy of the temporary stream control structures and facilities provided under this item and shall assume all risks of damage, of delay, and of every expense of whatever nature which may be caused within the areas allotted for the work of this contract by the waters of the West Branch of the Delaware River until the completion of the work.

Responsibility of Contractor.

SECT. 47.5 For all labor, equipment, materials, expenses, and costs, necessary to completely perform the work to be done under this item in the manner herein set forth and specified, the Contractor shall receive the lump sum stipulated for Item 47. Portions of temporary cofferdams built by the Contractor and allowed to remain as parts of ordered fills or embankments, ordered removal of temporary stream control structures built under

Payment.



Contract 460, the concrete stop logs, the construction of the plug in the diversion conduit, and the filling of the temporary release water piping and the 12-inch pipe through the concrete plug with concrete or grout, as ordered, will be included for payment under the appropriate items of this contract.

## SANITARY SERVICES

### ITEM 48

**Work  
included.**

SECT. 48.1 Under Item 48 the Contractor shall furnish the necessary labor, equipment, and materials not provided for under the other items of the contract, to satisfactorily operate and maintain the existing plants for the treatment of sewage and for the treatment of pumpage and drainage, any ordered additions to such existing treatment plants, and any ordered or approved additional plants for the treatment of sewage or pumpage and drainage; to satisfactorily treat and sterilize by chlorination or other approved means, to the extent ordered, water for drinking and construction purposes for use under this contract; to satisfactorily collect, transport, settle as required, and sterilize or otherwise satisfactorily dispose of excreta, sewage, garbage, and other putrescible wastes, of rubbish, and of dirty water and drainage from all sources about the work; to clean, disinfect, and fumigate all buildings of the contract, as required; to furnish medical and surgical care, hospital and other treatment for his employees; to administer emergency first aid treatment to any employees of The City injured on the work; to safeguard and maintain the quality of the waters of any water courses and water supplies affected by the work and prevent the waters from becoming harmful to fish, and to render all other required services that are considered by the Engineer and the sanitary authorities to be necessary to protect the public health as set forth in this and other sections of these specifications and in the state, county, and municipal regulations.

**Payment.**

SECT. 48.2 For all labor, equipment, materials, expenses, and costs, not properly to be classified under any other item or items, necessary to completely perform the work to be done under this item in the manner herein set forth and specified, the Contractor shall receive the lump sum stipulated for Item 48.

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CONSTRUCTION DRAWINGS



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# CONTRACT DRAWINGS

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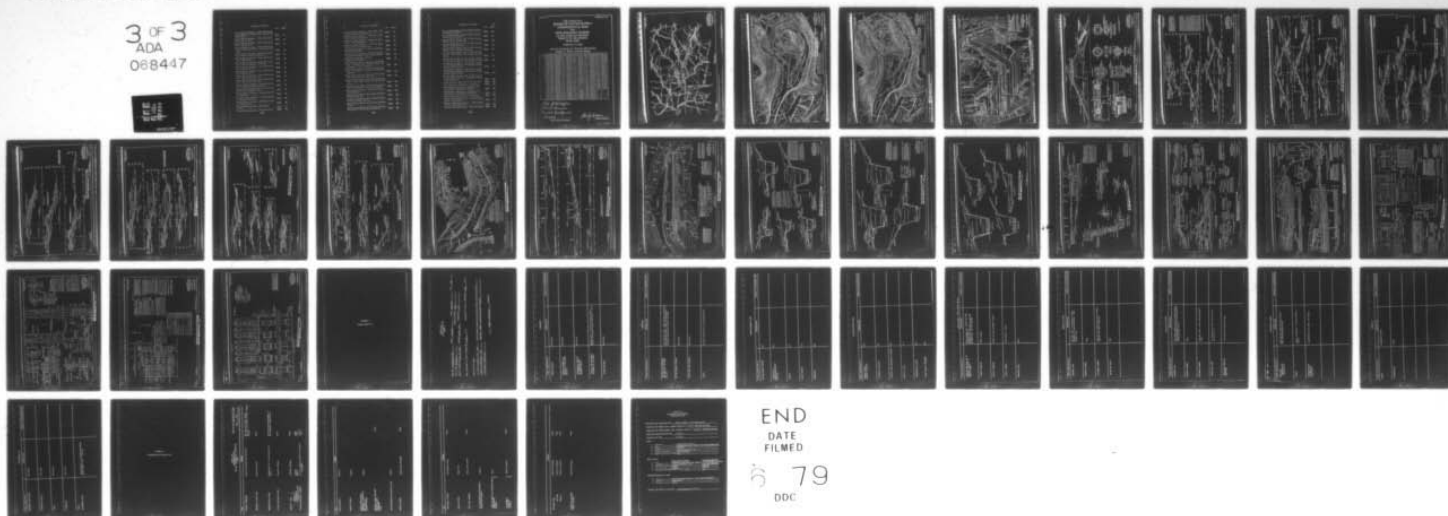
KIMBALL (L ROBERT) AND ASSOCIATES EBENSBURG PA  
NATIONAL DAM SAFETY PROGRAM. CANNONVILLE DAM;  
JUL 78 R J KIMBALL

F/G 13/2  
INVENTORY NUMBER--ETC(U)  
DACW51-78-C-0025

NL

UNCLASSIFIED

3 OF 3  
ADA  
068447



# CONTRACT DRAWINGS

V

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City of New York  
**BOARD OF WATER SUPPLY**  
**CANNONVILLE DAM**  
 AND  
**APPURTENANT WORKS**  
**IN THE TOWN OF DEPOSIT**  
**COUNTY OF DELAWARE**  
**NEW YORK**

FEBRUARY 15, 1960

Contract drawings for Contract 465 consist  
 of the 127 sheets as listed below:

Sheet	Accession	Sheet	Accession	Sheet	Accession	Sheet	Accession	Sheet	Accession	Sheet	Accession
81331	23	82322	45	82344	67	82365	89	82389	111	82407	
81332	24	82323	46	82345	68	82366	90	82390	112	82408	
81333	25	82324	47	82346	69	82367	91	82391	113	82409	
81338	26	82325	48	82347	70	82368	92	82392	114	82410	
81339	27	82326	49	82348	71	82369	93	82393	115	82411	
81340	28	82327	50	82349	72	82370	94	82536	116	82412	
81334	29	82328	51	82350	73	82371	95	82537	117	82413	
81335	30	82329	52	82351	74	82372	96	82538	118	82414	
81336	31	82330	53	82352	75	82373	97	82539	119	82415	
81337	32	82331	54	82353	76	82374	98	82540	120	82541	
81341	33	82332	55	82354	77	82375	99	82395	121	82542	
81342	34	82333	56	82532	78	82378	100	82396	122	81355	
81343	35	82334	57	82533	79	82379	101	82397	123	81356	
81344	36	82335	58	82356	80	82380	102	82398	124	81357	
81345	37	82336	59	82357	81	82381	103	82399	125	81358	
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81347	39	82338	61	82359	83	82383	105	82401	127	81360	
81348	40	82339	62	82360	84	82384	106	82402			
81349	41	82340	63	82361	85	82385	107	82403			
81350	42	82341	64	82362	86	82386	108	82404			
81351	43	82342	65	82363	87	82387	109	82405			
82321	44	82343	66	82364	88	82388	110	82406			

*Thos. H. Wiggin*  
*Paul R. Kennison*  
*Frank E. Fahlquist*

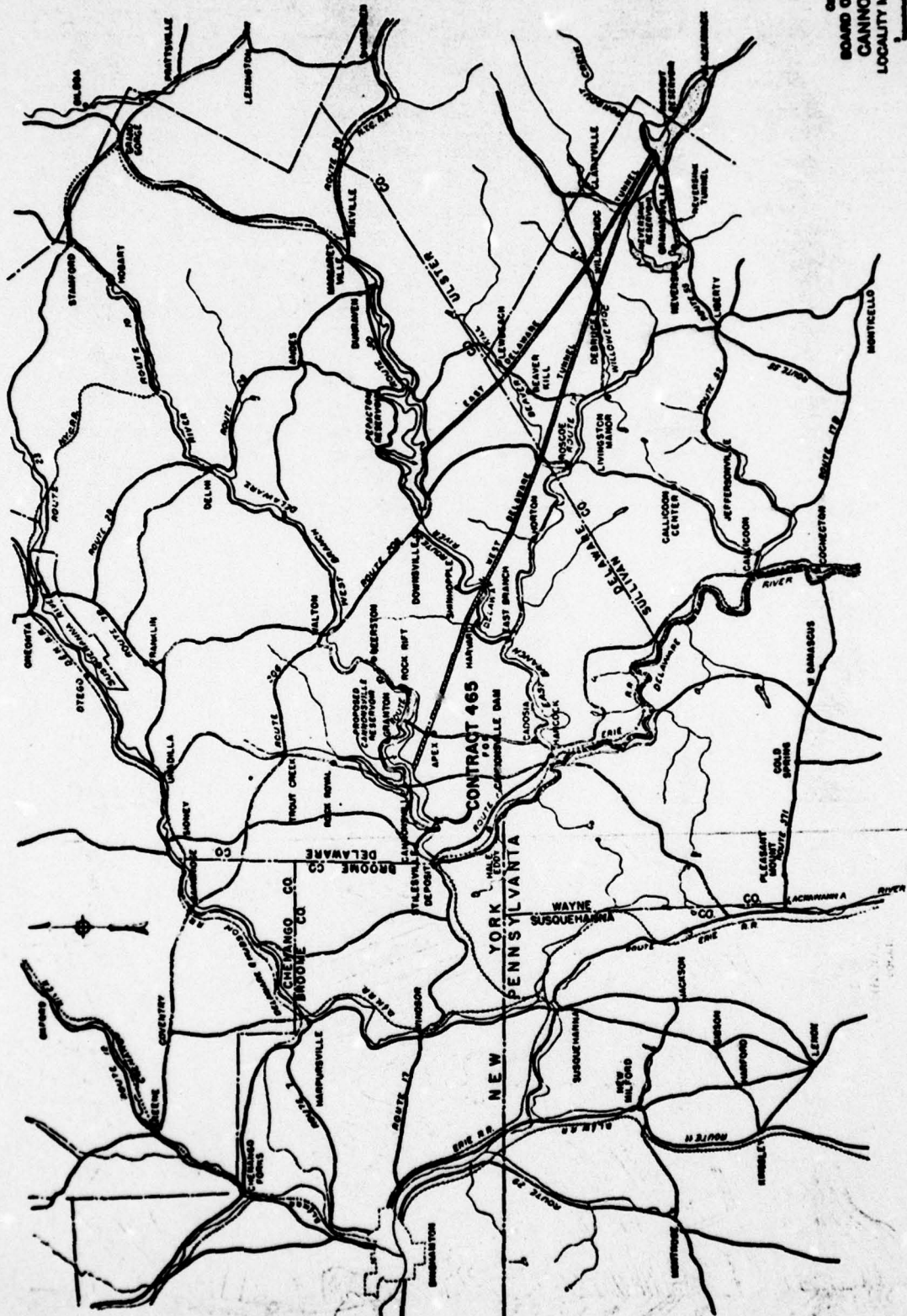
*Tomie Eide*  
 Consulting Engineers

*Stanley M. Dore*  
 Chief Engineer

CONTRACT 465 SHEET 1  
SHEETS IN SET, 127

City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
LOCALITY MAP - CONTRACT 465

FEBRUARY 18, 1900  
FILED COM. 465-3-457  
Aug. 9, 1934



*Charles S. ...*  
Project Engineer

*William ...*  
Assistant Engineer



CONTRACT 455 SHEET 2  
 SHEETS IN SET, 127

City of New York  
 BOARD OF WATER SUPPLY  
 CANNONSVILLE DAM  
 LOCATION PLAN

FEBRUARY 14, 1900  
 100 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000 7500 8000 8500 9000 9500 10000 10500 11000 11500 12000 12500 13000 13500 14000 14500 15000 15500 16000 16500 17000 17500 18000 18500 19000 19500 20000 20500 21000 21500 22000 22500 23000 23500 24000 24500 25000 25500 26000 26500 27000 27500 28000 28500 29000 29500 30000 30500 31000 31500 32000 32500 33000 33500 34000 34500 35000 35500 36000 36500 37000 37500 38000 38500 39000 39500 40000 40500 41000 41500 42000 42500 43000 43500 44000 44500 45000 45500 46000 46500 47000 47500 48000 48500 49000 49500 50000 50500 51000 51500 52000 52500 53000 53500 54000 54500 55000 55500 56000 56500 57000 57500 58000 58500 59000 59500 60000 60500 61000 61500 62000 62500 63000 63500 64000 64500 65000 65500 66000 66500 67000 67500 68000 68500 69000 69500 70000 70500 71000 71500 72000 72500 73000 73500 74000 74500 75000 75500 76000 76500 77000 77500 78000 78500 79000 79500 80000 80500 81000 81500 82000 82500 83000 83500 84000 84500 85000 85500 86000 86500 87000 87500 88000 88500 89000 89500 90000 90500 91000 91500 92000 92500 93000 93500 94000 94500 95000 95500 96000 96500 97000 97500 98000 98500 99000 99500 100000 100500 101000 101500 102000 102500 103000 103500 104000 104500 105000 105500 106000 106500 107000 107500 108000 108500 109000 109500 110000 110500 111000 111500 112000 112500 113000 113500 114000 114500 115000 115500 116000 116500 117000 117500 118000 118500 119000 119500 120000 120500 121000 121500 122000 122500 123000 123500 124000 124500 125000 125500 126000 126500 127000 127500 128000 128500 129000 129500 130000 130500 131000 131500 132000 132500 133000 133500 134000 134500 135000 135500 136000 136500 137000 137500 138000 138500 139000 139500 140000 140500 141000 141500 142000 142500 143000 143500 144000 144500 145000 145500 146000 146500 147000 147500 148000 148500 149000 149500 150000 150500 151000 151500 152000 152500 153000 153500 154000 154500 155000 155500 156000 156500 157000 157500 158000 158500 159000 159500 160000 160500 161000 161500 162000 162500 163000 163500 164000 164500 165000 165500 166000 166500 167000 167500 168000 168500 169000 169500 170000 170500 171000 171500 172000 172500 173000 173500 174000 174500 175000 175500 176000 176500 177000 177500 178000 178500 179000 179500 180000 180500 181000 181500 182000 182500 183000 183500 184000 184500 185000 185500 186000 186500 187000 187500 188000 188500 189000 189500 190000 190500 191000 191500 192000 192500 193000 193500 194000 194500 195000 195500 196000 196500 197000 197500 198000 198500 199000 199500 200000 200500 201000 201500 202000 202500 203000 203500 204000 204500 205000 205500 206000 206500 207000 207500 208000 208500 209000 209500 210000 210500 211000 211500 212000 212500 213000 213500 214000 214500 215000 215500 216000 216500 217000 217500 218000 218500 219000 219500 220000 220500 221000 221500 222000 222500 223000 223500 224000 224500 225000 225500 226000 226500 227000 227500 228000 228500 229000 229500 230000 230500 231000 231500 232000 232500 233000 233500 234000 234500 235000 235500 236000 236500 237000 237500 238000 238500 239000 239500 240000 240500 241000 241500 242000 242500 243000 243500 244000 244500 245000 245500 246000 246500 247000 247500 248000 248500 249000 249500 250000 250500 251000 251500 252000 252500 253000 253500 254000 254500 255000 255500 256000 256500 257000 257500 258000 258500 259000 259500 260000 260500 261000 261500 262000 262500 263000 263500 264000 264500 265000 265500 266000 266500 267000 267500 268000 268500 269000 269500 270000 270500 271000 271500 272000 272500 273000 273500 274000 274500 275000 275500 276000 276500 277000 277500 278000 278500 279000 279500 280000 280500 281000 281500 282000 282500 283000 283500 284000 284500 285000 285500 286000 286500 287000 287500 288000 288500 289000 289500 290000 290500 291000 291500 292000 292500 293000 293500 294000 294500 295000 295500 296000 29

City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
LOCATION PLAN

NO 0 100 0000  
FEBRUARY 13, 1969

George Spang  
Owner, The Exchange Inn

Madhyan No. 22 and  
Madhyan No. 23

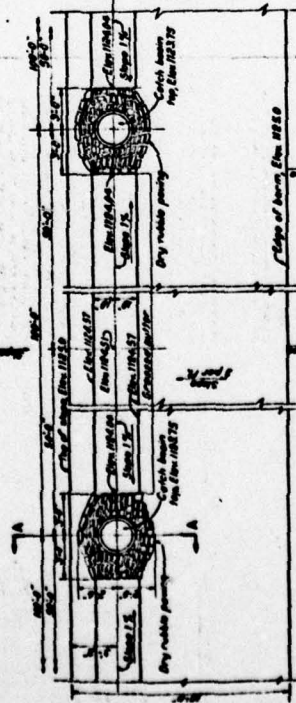




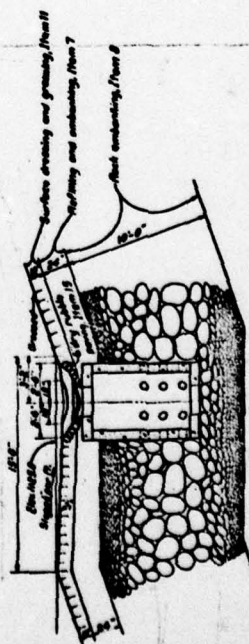




CONTRACT 465 SHEET 02  
SHEETS IN SET, 127



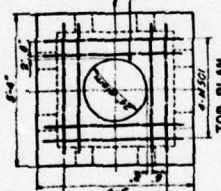
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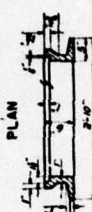
## SECTION A - A



**TOP OF DAM DETAIL**



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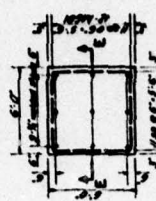
**SECTION C-C**  
**C.I. GRATING FRAME**



**SECTION D-D**



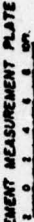
SECTION D-D  
C.I. GRATING  
17 required - Item 37 296  
6 1



12-2727  
P1 AM



SECTION E-E  
SETTLEMENT MEASUREMENT PLATE



The number and locations of  
settlement measurement plots  
shall be as ordered by the Engineer.

For plan of care and location of each  
business see Street H, Act 2141

**City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
DETAILS OF TOP OF DAM AND BASINS**

PL 50-1077-1000

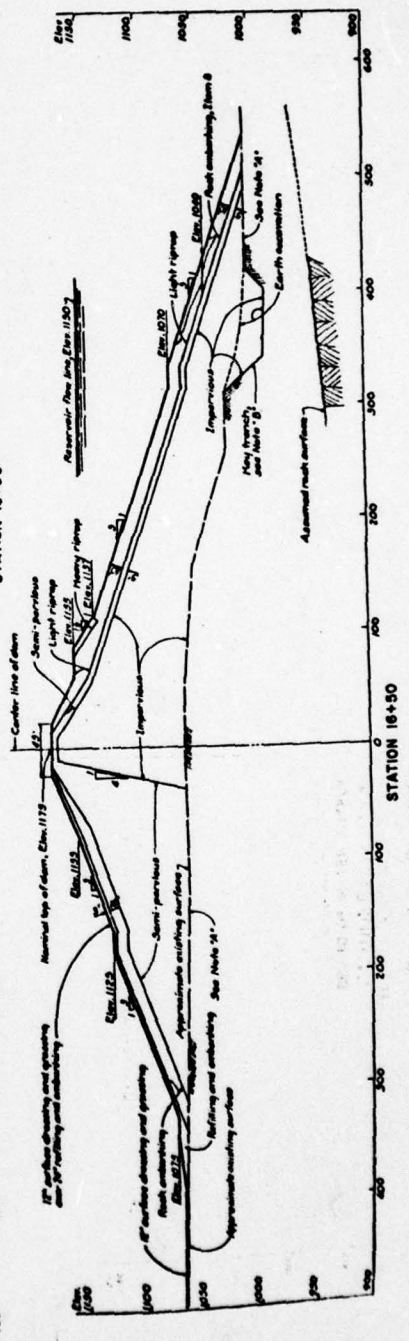
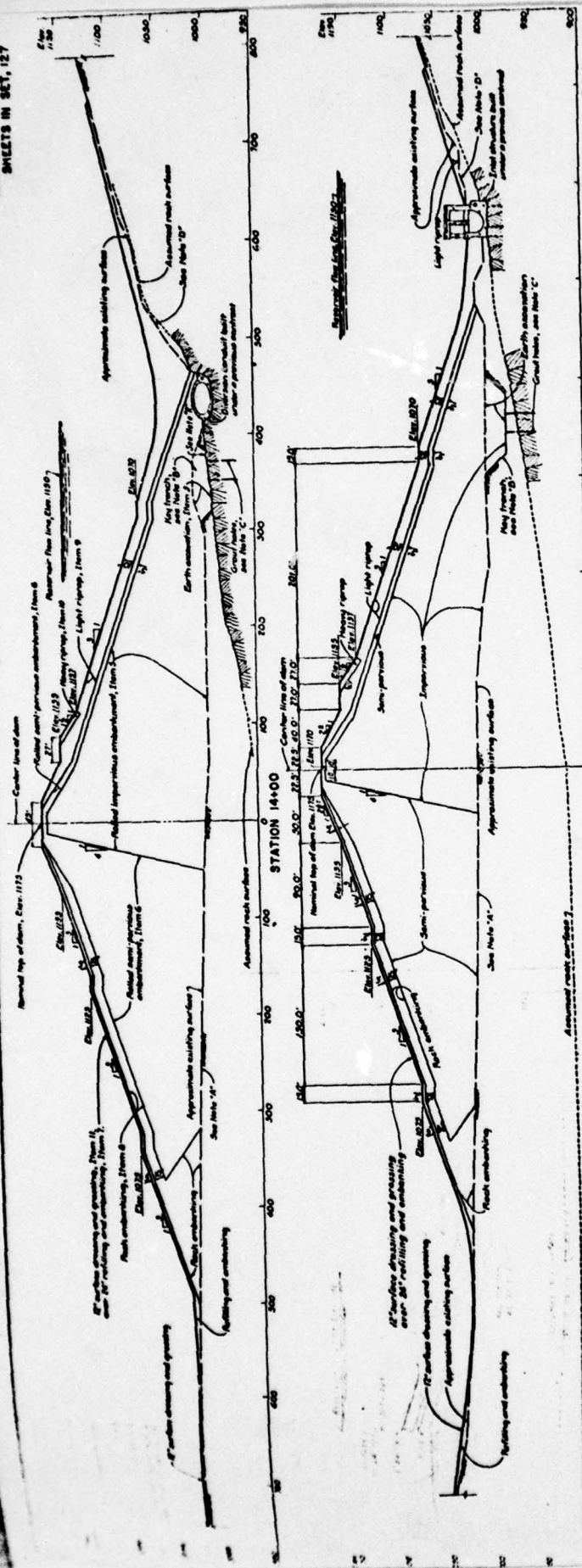
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 Derry Cliff Bay Deep Sea

Andrew Westlake





CONTRACT 465 SHEET 14  
SHEETS IN SET, 127



For location of existing dam, see Sheet 11, Set 2341.  
For location of existing dam, see Sheet 11, Set 2341.  
For location of existing dam, see Sheet 11, Set 2341.

City of New York  
BOARD OF WATER SUPPLY  
CANNONSVILLE DAM  
SECTIONS STA 14+00 TO STA 16+50

George A. ...  
Chief Civil Eng. Design Dept.

Thomas ...  
Assistant Engineer

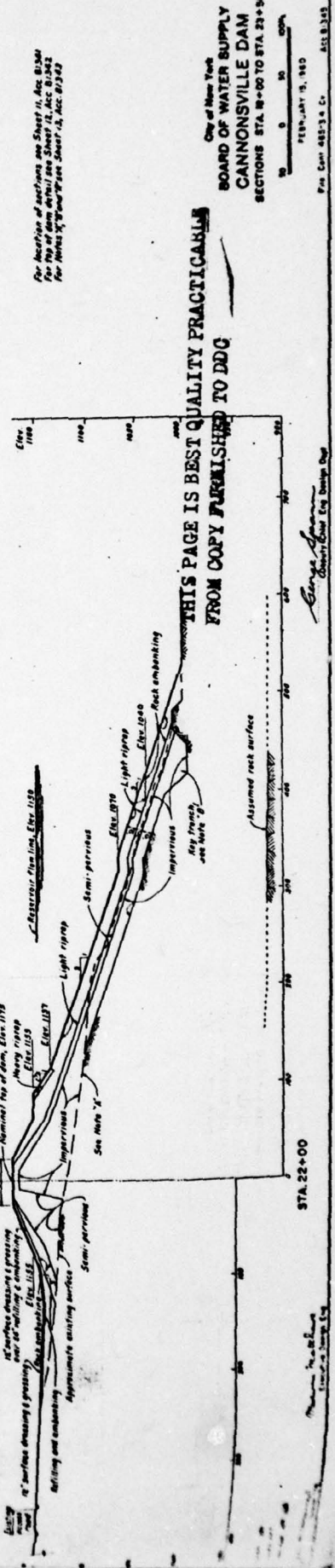
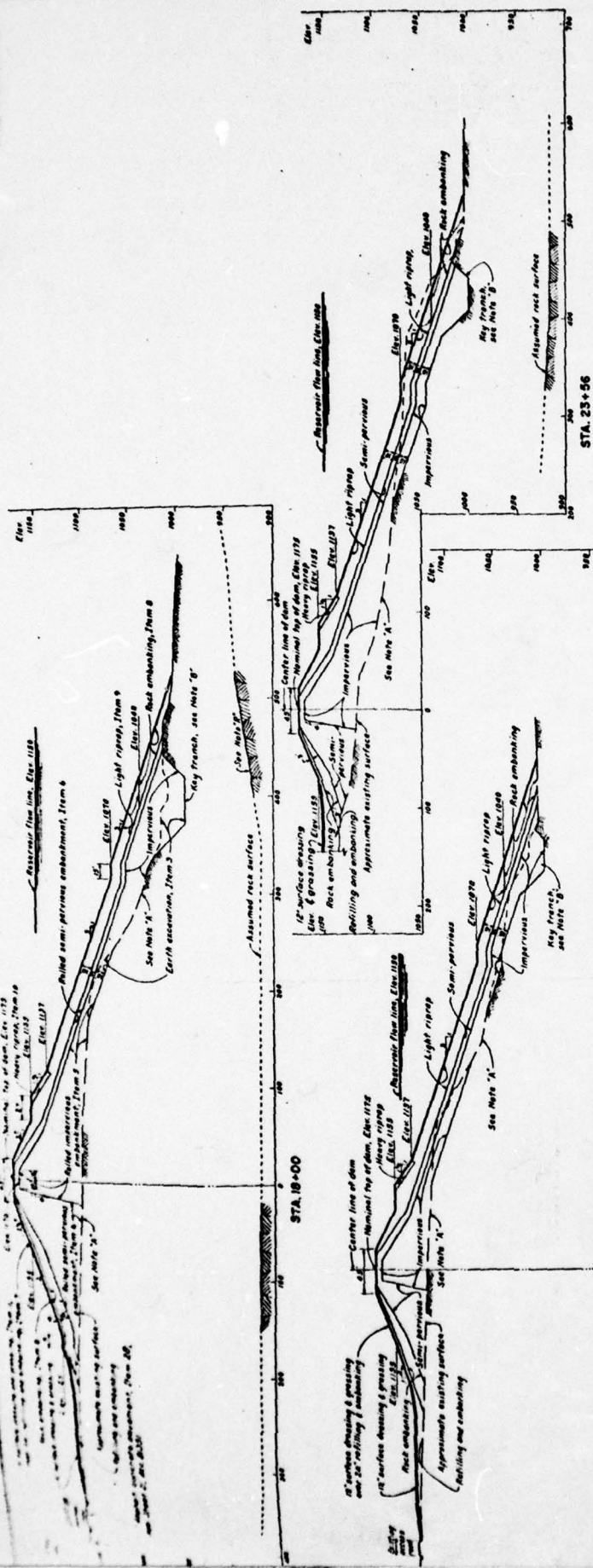
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City of New York  
BOARD OF WATER SUPPLY  
CANNONSVILLE DAM  
SECTIONS STA 14+00 TO STA 16+50

George A. ...  
Chief Civil Eng. Design Dept.

Thomas ...  
Assistant Engineer





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City of New York  
BOARD OF WATER SUPPLY  
CANNONSVILLE DAM  
SECTIONS STA 18+00 TO STA 23+56

For location of sections see Sheet 11, Acc. B-340  
For top of dam details see Sheet 12, Acc. B-342  
For Notes "x" through "z" see Sheet 13, Acc. B-343

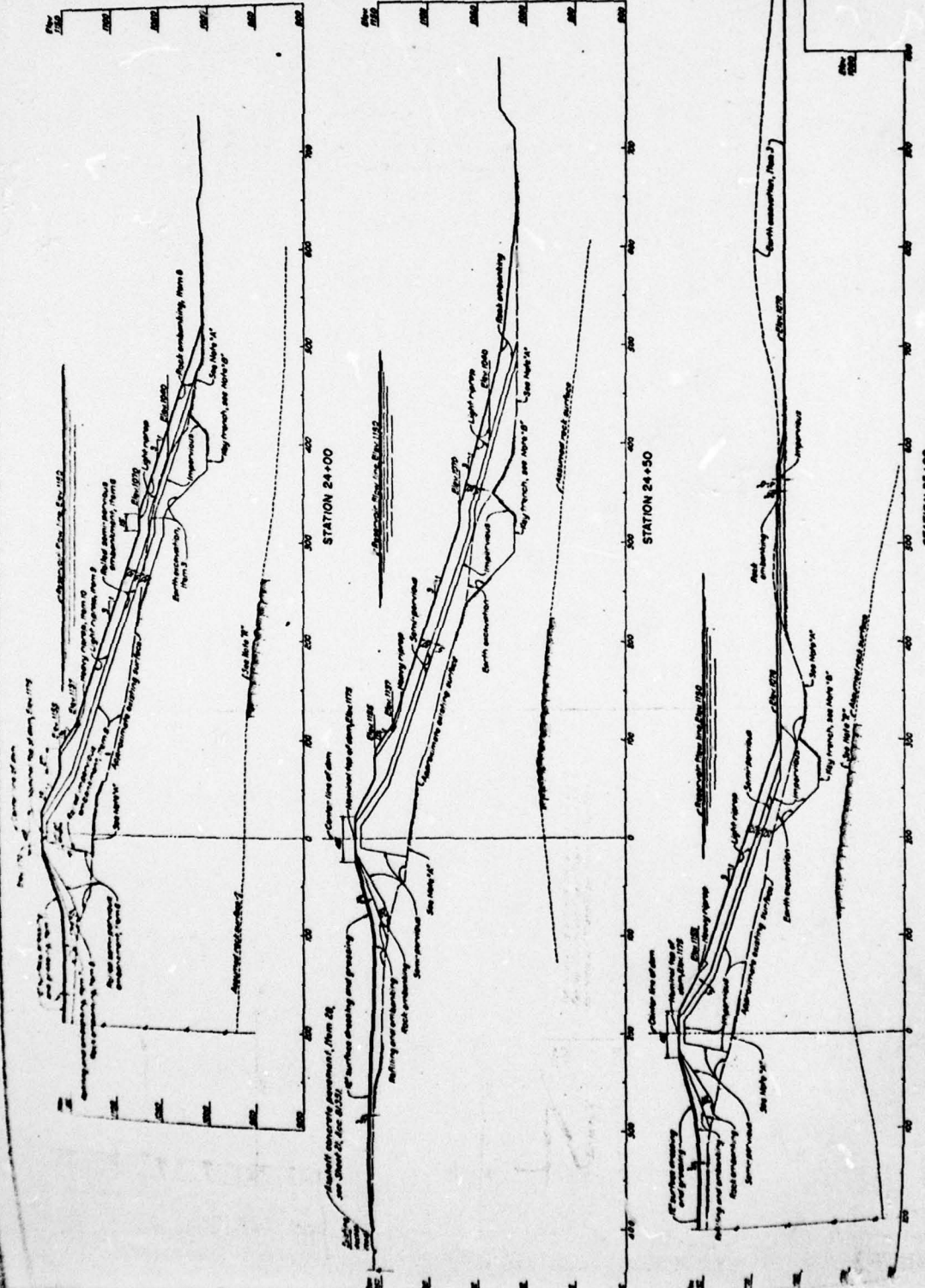
For location of sections see Sheet 11, Acc. B-340  
For top of dam details see Sheet 12, Acc. B-342  
For Notes "x" through "z" see Sheet 13, Acc. B-343

STA 20+00  
STA 23+56  
STA 22+00

0 100  
Feet

1915

CONTRACT 465 SHEET 16  
SHEETS IN SET, 127



For details of structure and details of dam  
see the plan view and section 16, and 17  
see the plan view and section 16, and 17

City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
SECTIONS STA 24+00 TO STA 25+00

February 19, 1930

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Medium Machine  
Section 16 of 17

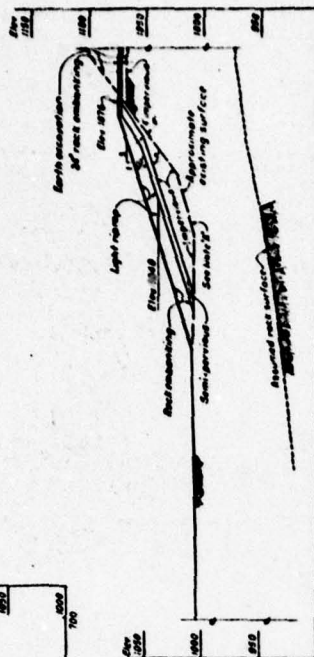
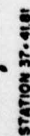
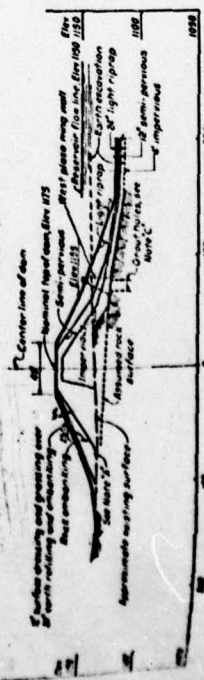
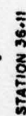
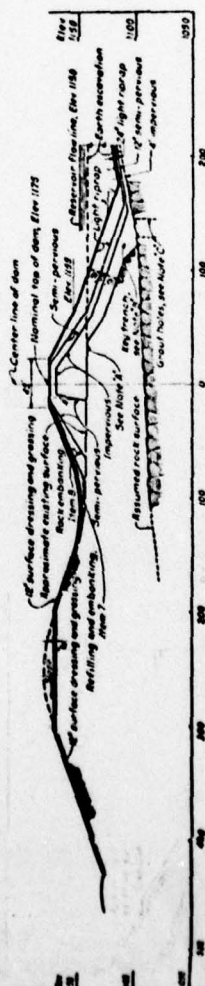
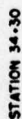
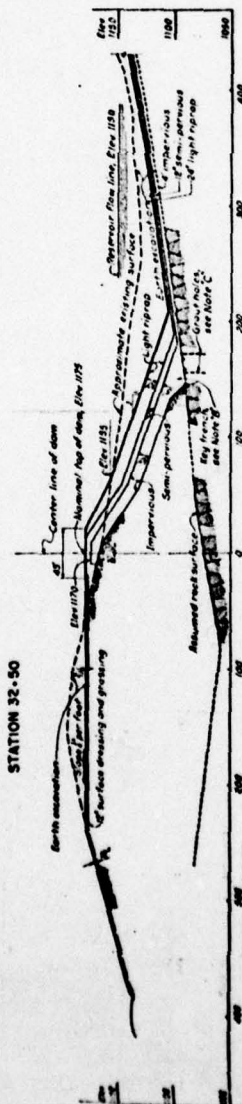
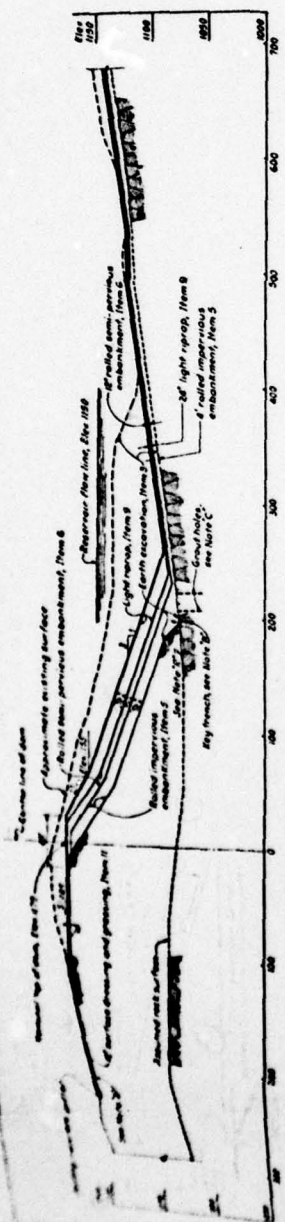
City of New York  
Board of Water Supply  
Cannonville Dam  
Section 16 of 17

February 19, 1930

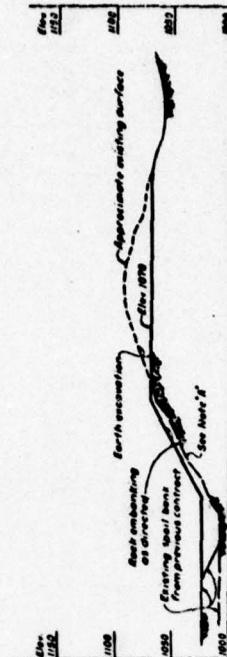




CONTRACT 465 SHEET 19  
SHEETS IN SET, 127



## SECTION M-M



## SECTION L-L

For location of sections see Sheet 11, Acc 01341  
for top of den delving see Sheet 12, Acc 01342  
for Moberg's "Tongue" see Sheet 13, Acc 01343

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**CITY OF NEW YORK**  
**BOARD OF WATER SUPPLY**  
**CANNONVILLE DAM**  
SECTIONS STA. 32+80 TO STA. 37+42

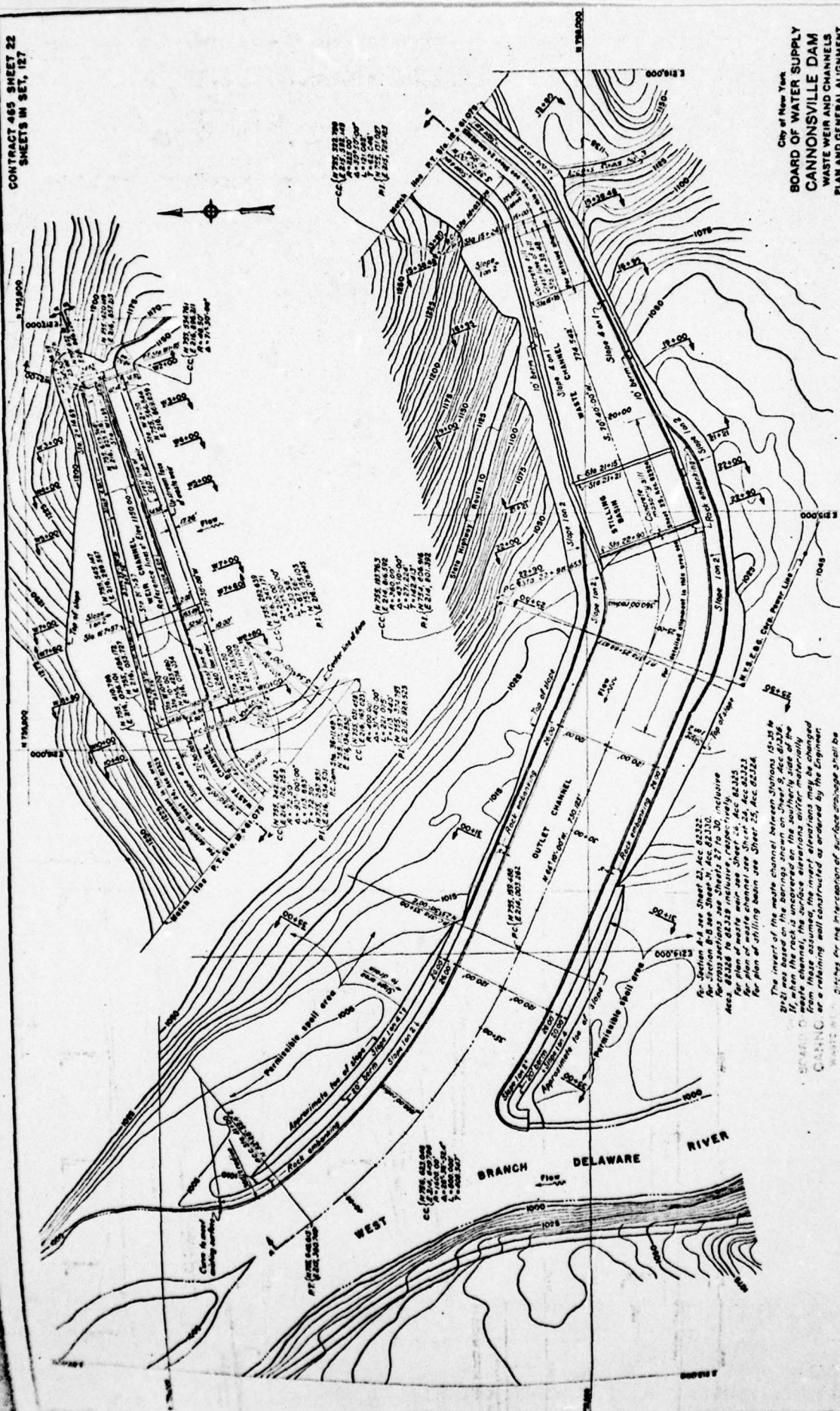
TO \_\_\_\_\_  
 FEBRUARY 15, 1940  
 File: Conf. 483-24 Co.      Aug 1917

*George Spahn*  
Deputy Chief Eng Design Dept.

Monks in a Redwood







City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
WASTE WEIR AND CHANNELS  
PLAN AND GENERAL ALIGNMENT

FEBRUARY 5 1960

File Cont 449-30 Co Att 0222

George Sparr  
Deputy Chief Eng. Design Dept.

Deputy Chief Eng. Design Dept.

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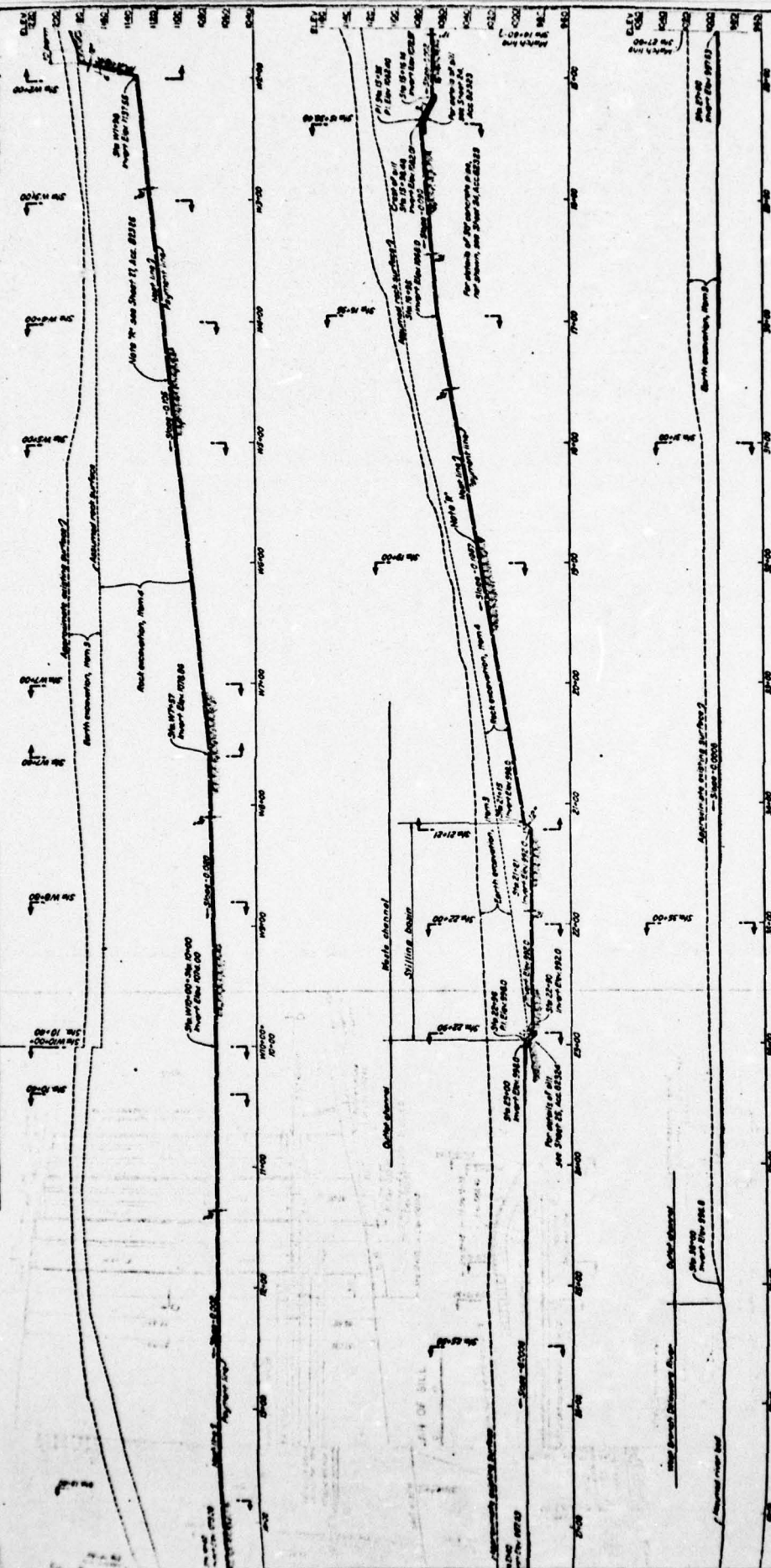
The invert of the waste channel between Stations 10+20 and 10+60 was based on the borings that were conducted at Station 10+38. It was assumed that the surface elevations on the authority side of the waste channel would be similar to those on the authority side of the waste channel. The surface elevations on the authority side of the waste channel were assumed to be the same as the surface elevations on the authority side of the waste channel. The surface elevations on the authority side of the waste channel were assumed to be the same as the surface elevations on the authority side of the waste channel.

For location plan see Sheet 2, Acc. 8132.  
See also: 8133, 8134, 8135, 8136, 8137, 8138, 8139, 8140, 8141, 8142, 8143, 8144, 8145, 8146, 8147, 8148, 8149, 8150, 8151, 8152, 8153, 8154, 8155, 8156, 8157, 8158, 8159, 8160, 8161, 8162, 8163, 8164, 8165, 8166, 8167, 8168, 8169, 8170, 8171, 8172, 8173, 8174, 8175, 8176, 8177, 8178, 8179, 8180, 8181, 8182, 8183, 8184, 8185, 8186, 8187, 8188, 8189, 8190, 8191, 8192, 8193, 8194, 8195, 8196, 8197, 8198, 8199, 8200, 8201, 8202, 8203, 8204, 8205, 8206, 8207, 8208, 8209, 8210, 8211, 8212, 8213, 8214, 8215, 8216, 8217, 8218, 8219, 8220, 8221, 8222, 8223, 8224, 8225, 8226, 8227, 8228, 8229, 8230, 8231, 8232, 8233, 8234, 8235, 8236, 8237, 8238, 8239, 8240, 8241, 8242, 8243, 8244, 8245, 8246, 8247, 8248, 8249, 8250, 8251, 8252, 8253, 8254, 8255, 8256, 8257, 8258, 8259, 8260, 8261, 8262, 8263, 8264, 8265, 8266, 8267, 8268, 8269, 8270, 8271, 8272, 8273, 8274, 8275, 8276, 8277, 8278, 8279, 8280, 8281, 8282, 8283, 8284, 8285, 8286, 8287, 8288, 8289, 8290, 8291, 8292, 8293, 8294, 8295, 8296, 8297, 8298, 8299, 8300, 8301, 8302, 8303, 8304, 8305, 8306, 8307, 8308, 8309, 8310, 8311, 8312, 8313, 8314, 8315, 8316, 8317, 8318, 8319, 8320, 8321, 8322, 8323, 8324, 8325, 8326, 8327, 8328, 8329, 8330, 8331, 8332, 8333, 8334, 8335, 8336, 8337, 8338, 8339, 8340, 8341, 8342, 8343, 8344, 8345, 8346, 8347, 8348, 8349, 8350, 8351, 8352, 8353, 8354, 8355, 8356, 8357, 8358, 8359, 8360, 8361, 8362, 8363, 8364, 8365, 8366, 8367, 8368, 8369, 8370, 8371, 8372, 8373, 8374, 8375, 8376, 8377, 8378, 8379, 8380, 8381, 8382, 8383, 8384, 8385, 8386, 8387, 8388, 8389, 8390, 8391, 8392, 8393, 8394, 8395, 8396, 8397, 8398, 8399, 8400, 8401, 8402, 8403, 8404, 8405, 8406, 8407, 8408, 8409, 8410, 8411, 8412, 8413, 8414, 8415, 8416, 8417, 8418, 8419, 8420, 8421, 8422, 8423, 8424, 8425, 8426, 8427, 8428, 8429, 8430, 8431, 8432, 8433, 8434, 8435, 8436, 8437, 8438, 8439, 8440, 8441, 8442, 8443, 8444, 8445, 8446, 8447, 8448, 8449, 8450, 8451, 8452, 8453, 8454, 8455, 8456, 8457, 8458, 8459, 8460, 8461, 8462, 8463, 8464, 8465, 8466, 8467, 8468, 8469, 8470, 8471, 8472, 8473, 8474, 8475, 8476, 8477, 8478, 8479, 8480, 8481, 8482, 8483, 8484, 8485, 8486, 8487, 8488, 8489, 8490, 8491, 8492, 8493, 8494, 8495, 8496, 8497, 8498, 8499, 8500, 8501, 8502, 8503, 8504, 8505, 8506, 8507, 8508, 8509, 8510, 8511, 8512, 8513, 8514, 8515, 8516, 8517, 8518, 8519, 8520, 8521, 8522, 8523, 8524, 8525, 8526, 8527, 8528, 8529, 8530, 8531, 8532, 8533, 8534, 8535, 8536, 8537, 8538, 8539, 8540, 8541, 8542, 8543, 8544, 8545, 8546, 8547, 8548, 8549, 8550, 8551, 8552, 8553, 8554, 8555, 8556, 8557, 8558, 8559, 8560, 8561, 8562, 8563, 8564, 8565, 8566, 8567, 8568, 8569, 8570, 8571, 8572, 8573, 8574, 8575, 8576, 8577, 8578, 8579, 8580, 8581, 8582, 8583, 8584, 8585, 8586, 8587, 8588, 8589, 8590, 8591, 8592, 8593, 8594, 8595, 8596, 8597, 8598, 8599, 8600, 8601, 8602, 8603, 8604, 8605, 8606, 8607, 8608, 8609, 8610, 8611, 8612, 8613, 8614, 8615, 8616, 8617, 8618, 8619, 8620, 8621, 8622, 8623, 8624, 8625, 8626, 8627, 8628, 8629, 8630, 8631, 8632, 8633, 8634, 8635, 8636, 8637, 8638, 8639, 8640, 8641, 8642, 8643, 8644, 8645, 8646, 8647, 8648, 8649, 8650, 8651, 8652, 8653, 8654, 8655, 8656, 8657, 8658, 8659, 8660, 8661, 8662, 8663, 8664, 8665, 8666, 8667, 8668, 8669, 8670, 8671, 8672, 8673, 8674, 8675, 8676, 8677, 8678, 8679, 8680, 8681, 8682, 8683, 8684, 8685, 8686, 8687, 8688, 8689, 8690, 8691, 8692, 8693, 8694, 8695, 8696, 8697, 8698, 8699, 8700, 8701, 8702, 8703, 8704, 8705, 8706, 8707, 8708, 8709, 8710, 8711, 8712, 8713, 8714, 8715, 8716, 8717, 8718, 8719, 8720, 8721, 8722, 8723, 8724, 8725, 8726, 8727, 8728, 8729, 8730, 8731, 8732, 8733, 8734, 8735, 8736, 8737, 8738, 8739, 8740, 8741, 8742, 8743, 8744, 8745, 8746, 8747, 8748, 8749, 8750, 8751, 8752, 8753, 8754, 8755, 8756, 8757, 8758, 8759, 8760, 8761, 8762, 8763, 8764, 8765, 8766, 8767, 8768, 8769, 8770, 8771, 8772, 8773, 8774, 8775, 8776, 8777, 8778, 8779, 8780, 8781, 8782, 8783, 8784, 8785, 8786, 8787, 8788, 8789, 8790, 8791, 8792, 8793, 8794, 8795, 8796, 8797, 8798, 8799, 8800, 8801, 8802, 8803, 8804, 8805, 8806, 8807, 8808, 8809, 8810, 8811

*Quercus laevis*



CONTRACT 465 SHEET 25  
SHEETS IN SET, 127



City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
WASTE WEIR AND CHANNELS  
PROFILE - SECTION A-A

1" = 100' - 1" = 30.48 m  
FEB-JAN 19, 1905

*Ernest Ingersoll*  
Chief Engineer

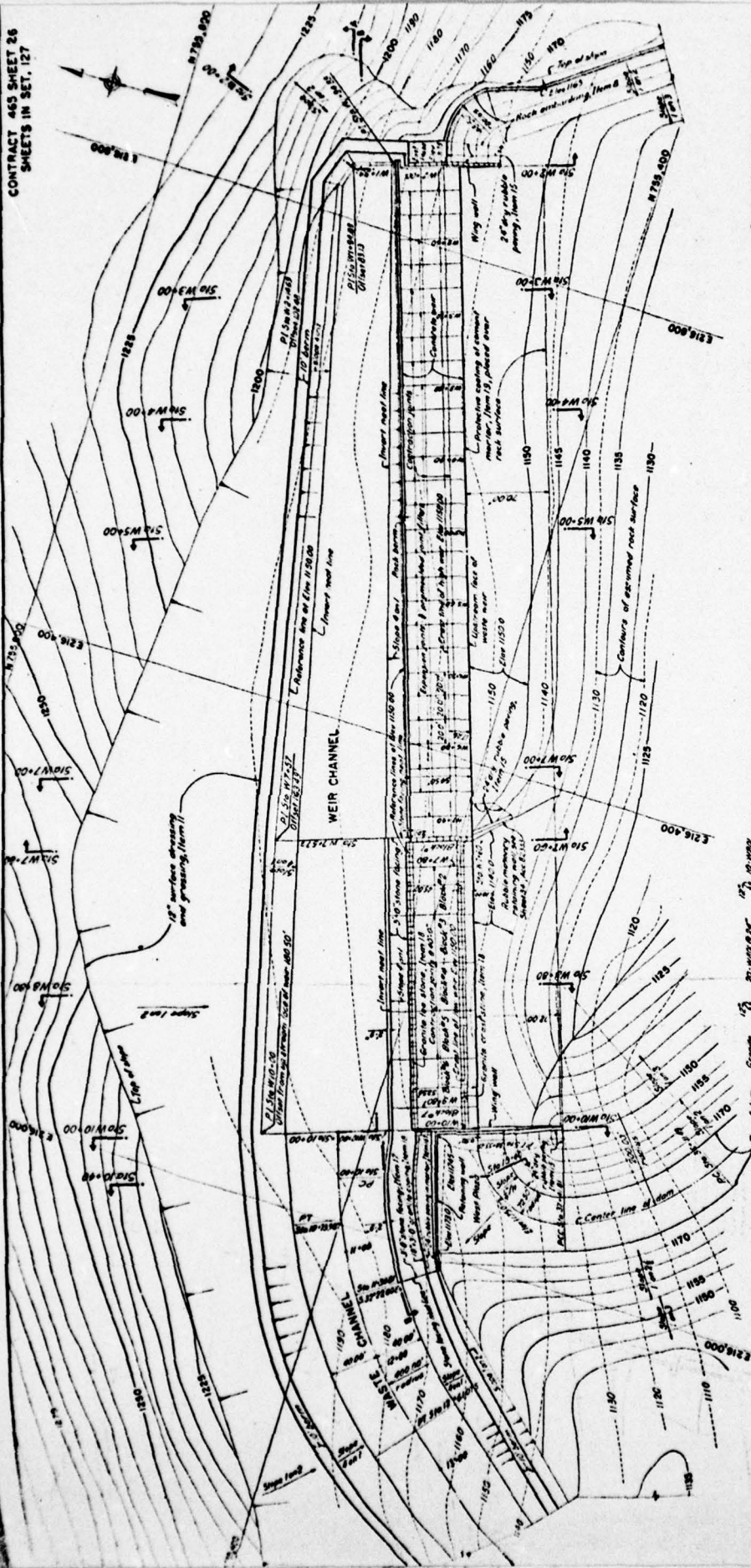
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For plan and location of Section A-A see Sheet 22, Aug. 8, 1903.  
For cross sections see Sheets 27 to 30 inclusive, Dec. 1, 1903.  
82226 N 82227 Inclusive, respectively.

BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
WASTE WEIR AND CHANNELS  
PROFILE - SECTION A-A

*Ernest Ingersoll*  
Chief Engineer

CONTRACT 463 SHEET 26  
SHEETS IN SET, 127

[illegible]

For plan of dem area Sheet 11, Acc 0126L.  
For alignment of north east and diagonals  
see Sheet 32, Acc 0126I.  
For Section A-B see Sheet 23, Acc 0126J  
For Section B-C see Sheet 31, Acc 0126K  
For cross section and Sheet 37, 38 and  
29, Acc 0126L, 0126M and 0126N, respectively.  
For average drainage area Sheet 31, Acc 0126O  
Sheet 37, typical section of north west area  
Sheet 38, typical section of north west area  
For Section C-D see Sheet 39, Acc 0126P  
For junction of high and low areas see  
Sheet 34, Acc 0126Q  
For Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797

**CITY OF NEW YORK  
BOARD OF WATER SUPPLY  
CANNONSVILLE DAM  
WASTE WEIR AND WEIR CHANNEL**

40 0 40 80  
12 JAN 12, 1960  
10 Cont 453-145

*George L. ...*



### PLAN OF REINFORCEMENT

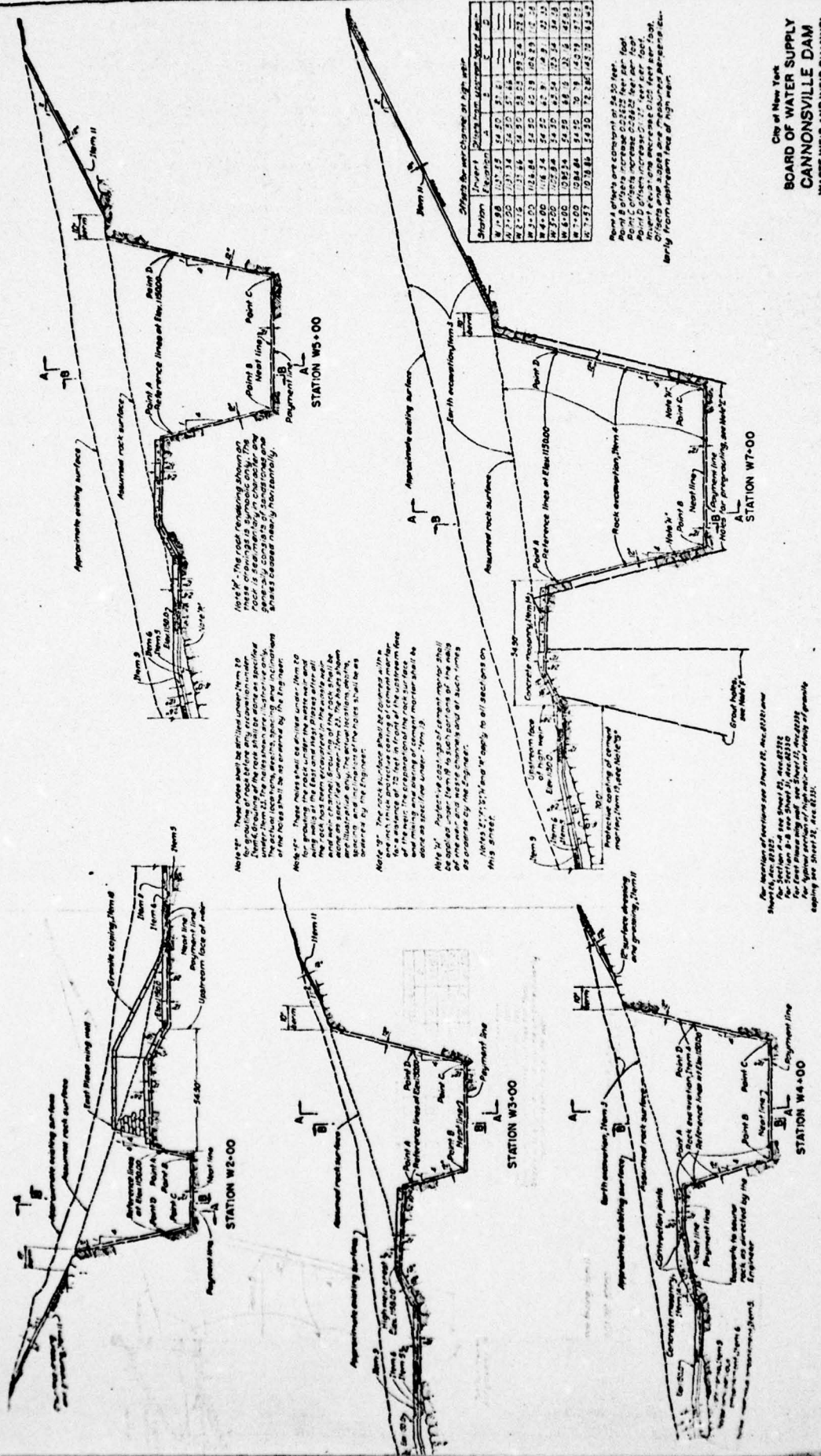
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the 1970s, the 1980s, and the 1990s. The 1970s were a time of great change for the world, and the 1980s were a time of great change for the United States. The 1990s were a time of great change for the world, and the 2000s were a time of great change for the United States. The 2010s were a time of great change for the world, and the 2020s were a time of great change for the United States.

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*[Faint handwritten notes at the bottom of the page]*





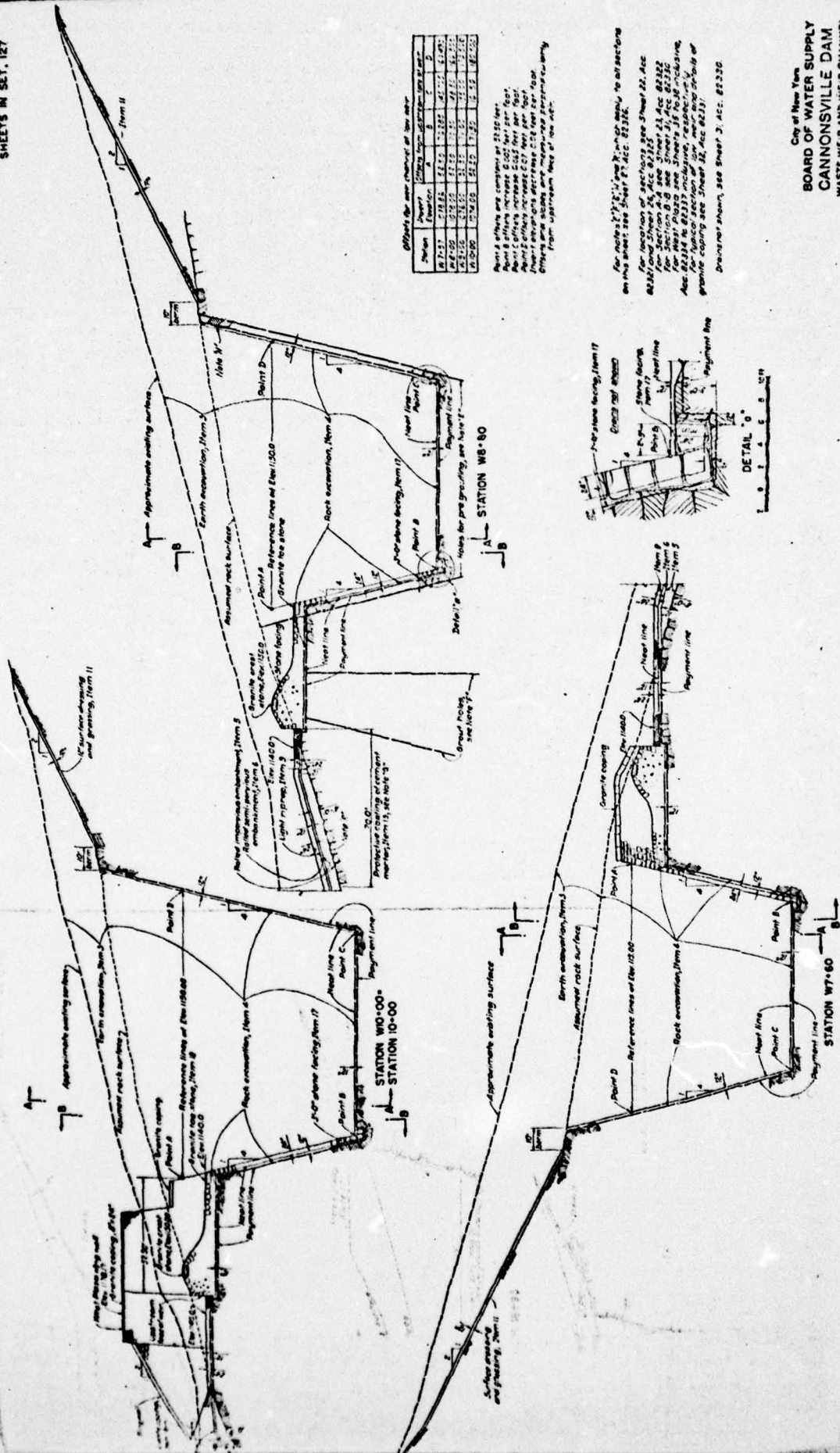
Station	Elevation	Width	Depth	Angle	Notes
W 1+00	117.55	14.50	3.0	—	—
W 2+00	121.34	14.50	3.0	—	—
W 3+00	121.34	14.50	3.0	—	—
W 4+00	121.34	14.50	3.0	—	—
W 5+00	121.34	14.50	3.0	—	—
W 6+00	121.34	14.50	3.0	—	—
W 7+00	121.34	14.50	3.0	—	—

City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
WASTE WEIR AND WEIR CHANNEL  
HIGH WEIR - SECTIONS

20 0 20 40  
FEBRUARY 1, 1910  
Per Contract 465-2-A-C  
A.C. 87218

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Engineer  
Checked Out by Design



Offsets for new channel at low water

Station	Point	Offset from center line	Point	Offset	Point	Offset
W0+00	1	11.85	2	11.85	3	11.85
W0+00	4	11.85	5	11.85	6	11.85
W0+00	7	11.85	8	11.85	9	11.85
W0+00	10	11.85	11	11.85	12	11.85
W0+00	13	11.85	14	11.85	15	11.85
W0+00	16	11.85	17	11.85	18	11.85
W0+00	19	11.85	20	11.85	21	11.85
W0+00	22	11.85	23	11.85	24	11.85
W0+00	25	11.85	26	11.85	27	11.85
W0+00	28	11.85	29	11.85	30	11.85
W0+00	31	11.85	32	11.85	33	11.85
W0+00	34	11.85	35	11.85	36	11.85
W0+00	37	11.85	38	11.85	39	11.85
W0+00	40	11.85	41	11.85	42	11.85
W0+00	43	11.85	44	11.85	45	11.85
W0+00	46	11.85	47	11.85	48	11.85
W0+00	49	11.85	50	11.85	51	11.85
W0+00	52	11.85	53	11.85	54	11.85
W0+00	55	11.85	56	11.85	57	11.85
W0+00	58	11.85	59	11.85	60	11.85
W0+00	61	11.85	62	11.85	63	11.85
W0+00	64	11.85	65	11.85	66	11.85
W0+00	67	11.85	68	11.85	69	11.85
W0+00	70	11.85	71	11.85	72	11.85
W0+00	73	11.85	74	11.85	75	11.85
W0+00	76	11.85	77	11.85	78	11.85
W0+00	79	11.85	80	11.85	81	11.85
W0+00	82	11.85	83	11.85	84	11.85
W0+00	85	11.85	86	11.85	87	11.85
W0+00	88	11.85	89	11.85	90	11.85
W0+00	91	11.85	92	11.85	93	11.85
W0+00	94	11.85	95	11.85	96	11.85
W0+00	97	11.85	98	11.85	99	11.85
W0+00	100	11.85	101	11.85	102	11.85
W0+00	103	11.85	104	11.85	105	11.85
W0+00	106	11.85	107	11.85	108	11.85
W0+00	109	11.85	110	11.85	111	11.85
W0+00	112	11.85	113	11.85	114	11.85
W0+00	115	11.85	116	11.85	117	11.85
W0+00	118	11.85	119	11.85	120	11.85
W0+00	121	11.85	122	11.85	123	11.85
W0+00	124	11.85	125	11.85	126	11.85
W0+00	127	11.85	128	11.85	129	11.85
W0+00	130	11.85	131	11.85	132	11.85
W0+00	133	11.85	134	11.85	135	11.85
W0+00	136	11.85	137	11.85	138	11.85
W0+00	139	11.85	140	11.85	141	11.85
W0+00	142	11.85	143	11.85	144	11.85
W0+00	145	11.85	146	11.85	147	11.85
W0+00	148	11.85	149	11.85	150	11.85
W0+00	151	11.85	152	11.85	153	11.85
W0+00	154	11.85	155	11.85	156	11.85
W0+00	157	11.85	158	11.85	159	11.85
W0+00	160	11.85	161	11.85	162	11.85
W0+00	163	11.85	164	11.85	165	11.85
W0+00	166	11.85	167	11.85	168	11.85
W0+00	169	11.85	170	11.85	171	11.85
W0+00	172	11.85	173	11.85	174	11.85
W0+00	175	11.85	176	11.85	177	11.85
W0+00	178	11.85	179	11.85	180	11.85
W0+00	181	11.85	182	11.85	183	11.85
W0+00	184	11.85	185	11.85	186	11.85
W0+00	187	11.85	188	11.85	189	11.85
W0+00	190	11.85	191	11.85	192	11.85
W0+00	193	11.85	194	11.85	195	11.85
W0+00	196	11.85	197	11.85	198	11.85
W0+00	199	11.85	200	11.85	201	11.85
W0+00	202	11.85	203	11.85	204	11.85
W0+00	205	11.85	206	11.85	207	11.85
W0+00	208	11.85	209	11.85	210	11.85
W0+00	211	11.85	212	11.85	213	11.85
W0+00	214	11.85	215	11.85	216	11.85
W0+00	217	11.85	218	11.85	219	11.85
W0+00	220	11.85	221	11.85	222	11.85
W0+00	223	11.85	224	11.85	225	11.85
W0+00	226	11.85	227	11.85	228	11.85
W0+00	229	11.85	230	11.85	231	11.85
W0+00	232	11.85	233	11.85	234	11.85
W0+00	235	11.85	236	11.85	237	11.85
W0+00	238	11.85	239	11.85	240	11.85
W0+00	241	11.85	242	11.85	243	11.85
W0+00	244	11.85	245	11.85	246	11.85
W0+00	247	11.85	248	11.85	249	11.85
W0+00	250	11.85	251	11.85	252	11.85
W0+00	253	11.85	254	11.85	255	11.85
W0+00	256	11.85	257	11.85	258	11.85
W0+00	259	11.85	260	11.85	261	11.85
W0+00	262	11.85	263	11.85	264	11.85
W0+00	265	11.85	266	11.85	267	11.85
W0+00	268	11.85	269	11.85	270	11.85
W0+00	271	11.85	272	11.85	273	11.85
W0+00	274	11.85	275	11.85	276	11.85
W0+00	277	11.85	278	11.85	279	11.85
W0+00	280	11.85	281	11.85	282	11.85
W0+00	283	11.85	284	11.85	285	11.85
W0+00	286	11.85	287	11.85	288	11.85
W0+00	289	11.85	290	11.85	291	11.85
W0+00	292	11.85	293	11.85	294	11.85
W0+00	295	11.85	296	11.85	297	11.85
W0+00	298	11.85	299	11.85	300	11.85
W0+00	301	11.85	302	11.85	303	11.85
W0+00	304	11.85	305	11.85	306	11.85
W0+00	307	11.85	308	11.85	309	11.85
W0+00	310	11.85	311	11.85	312	11.85
W0+00	313	11.85	314	11.85	315	11.85
W0+00	316	11.85	317	11.85	318	11.85
W0+00	319	11.85	320	11.85	321	11.85
W0+00	322	11.85	323	11.85	324	11.85
W0+00	325	11.85	326	11.85	327	11.85
W0+00	328	11.85	329	11.85	330	11.85
W0+00	331	11.85	332	11.85	333	11.85
W0+00	334	11.85	335	11.85	336	11.85
W0+00	337	11.85	338	11.85	339	11.85
W0+00	340	11.85	341	11.85	342	11.85
W0+00	343	11.85	344	11.85	345	11.85
W0+00	346	11.85	347	11.85	348	11.85
W0+00	349	11.85	350	11.85	351	11.85
W0+00	352	11.85	353	11.85	354	11.85
W0+00	355	11.85	356	11.85	357	11.85
W0+00	358	11.85	359	11.85	360	11.85
W0+00	361	11.85	362	11.85	363	11.85
W0+00	364	11.85	365	11.85	366	11.85
W0+00	367	11.85	368	11.85	369	11.85
W0+00	370	11.85	371	11.85	372	11.85
W0+00	373	11.85	374	11.85	375	11.85
W0+00	376	11.85	377	11.85	378	11.85
W0+00	379	11.85	380	11.85	381	11.85
W0+00	382	11.85	383	11.85	384	11.85
W0+00	385	11.85	386	11.85	387	11.85
W0+00	388	11.85	389	11.85	390	11.85
W0+00	391	11.85	392	11.85	393	11.85
W0+00	394	11.85	395	11.85	396	11.85
W0+00	397	11.85	398	11.85	399	11.85
W0+00	400	11.85	401	11.85	402	11.85
W0+00	403	11.85	404	11.85	405	11.85
W0+00	406	11.85	407	11.85	408	11.85
W0+00	409	11.85	410	11.85	411	11.85
W0+00	412	11.85	413	11.85	414	11.85
W0+00	415	11.85	416	11.85	417	11.85
W0+00	418	11.85	419	11.85	420	11.85
W0+00	421	11.85	422	11.85	423	11.85
W0+00	424	11.85	425	11.85	426	11.85
W0+00	427	11.85	428	11.85	429	11.85
W0+00	430	11.85	431	11.85	432	11.85
W0+00	433	11.85	434	11.85	435	11.85
W0+00	436	11.85	437	11.85	438	11.85
W0+00	439	11.85	440	11.85	441	11.85
W0+00	442	11.85	443	11.85	444	11.85
W0+00	445	11.85	446	11.85	447	11.85
W0+00	448	11.85	449	11.85	450	11.85
W0+00	451	11.85	452	11.85	453	11.85
W0+00	454	11.85	455	11.85	456	11.85
W0+00	457	11.85	458	11.85	459	11.85
W0+00	460	11.85	461	11.85	462	11.85
W0+00	463	11.85	464	11.85	465	11.85
W0+00	466	11.85	467	11.85	468	11.85



City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
WASTE CHANNEL  
SECTIONS

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Case 3:  $\lambda = 0$

Acc 02520

714 COM 022 - J4C0

George Sparran  
President, Chert Fire Design Board

Production Transitions  
Positive Change Log

[illegible]

**General notes.** This drawing is to be considered as merely illustrative of the general location and arrangement of the proposed construction and is not necessarily to be placed in straight lines and evenly spaced as shown herein but will be located in the field as required to meet actual conditions. The location of the proposed construction shall not be subject to change.

It is of first importance that all the locations shown on this drawing be carefully checked and verified in the field before any work is started. Drains will be located to provide slopes for the proposed ditches. The soil will not be so located as to provide for the proposed ditches.

Let's it shown on the drawing to indicate the method of work in construction and to indicate the location of the proposed construction.

**SECTION 8-B**

## SECTION 2.0

## SECTION 9-0

SECTION b-b

**CITY OF NEW YORK**  
**BOARD OF WATER SUPPLY**  
**CANNONVILLE DAM**  
**WASTE WEIR AND WEIR CHANNEL**  
**SEEPAGE DRAINS - SECTIONS**

**TYPICAL SECTION OF  
DRAINAGE AT STONE FACING**

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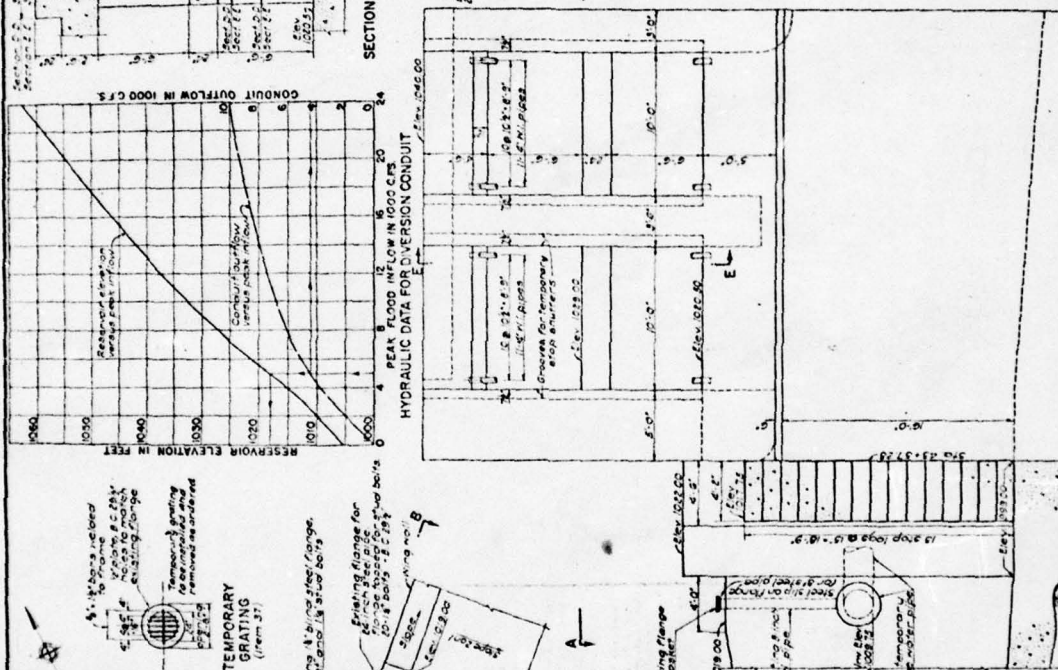
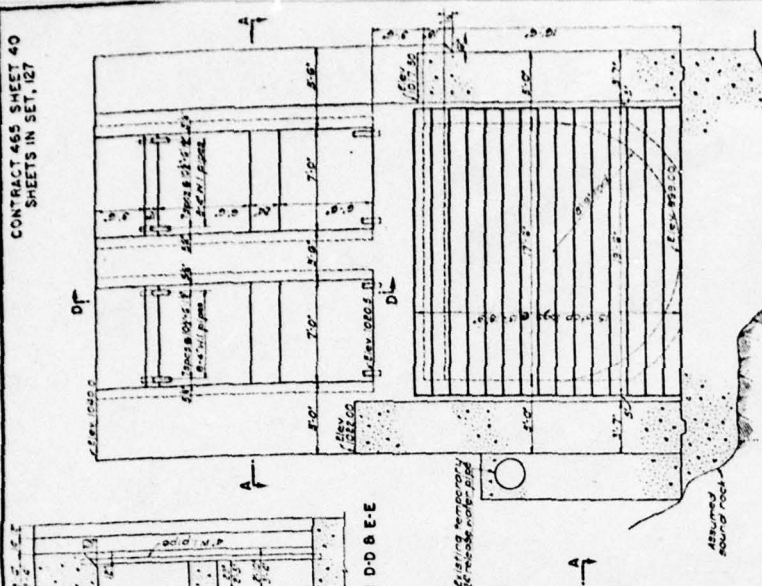
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 Apr 21 1955





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SECTION C-C

[illegible]

*City of New York*  
**BOARD OF WATER SUPPLY  
CANNONSVILLE DAM  
EXISTING INLET STRUCTURE  
STOP LOGS  
PLANS AND SECTIONS**

RECEIVED  
JAN 25 1960  
U.S. AIR FORCE

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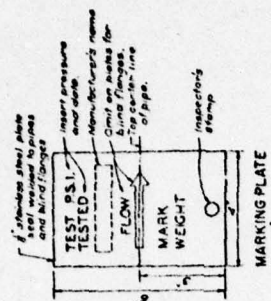
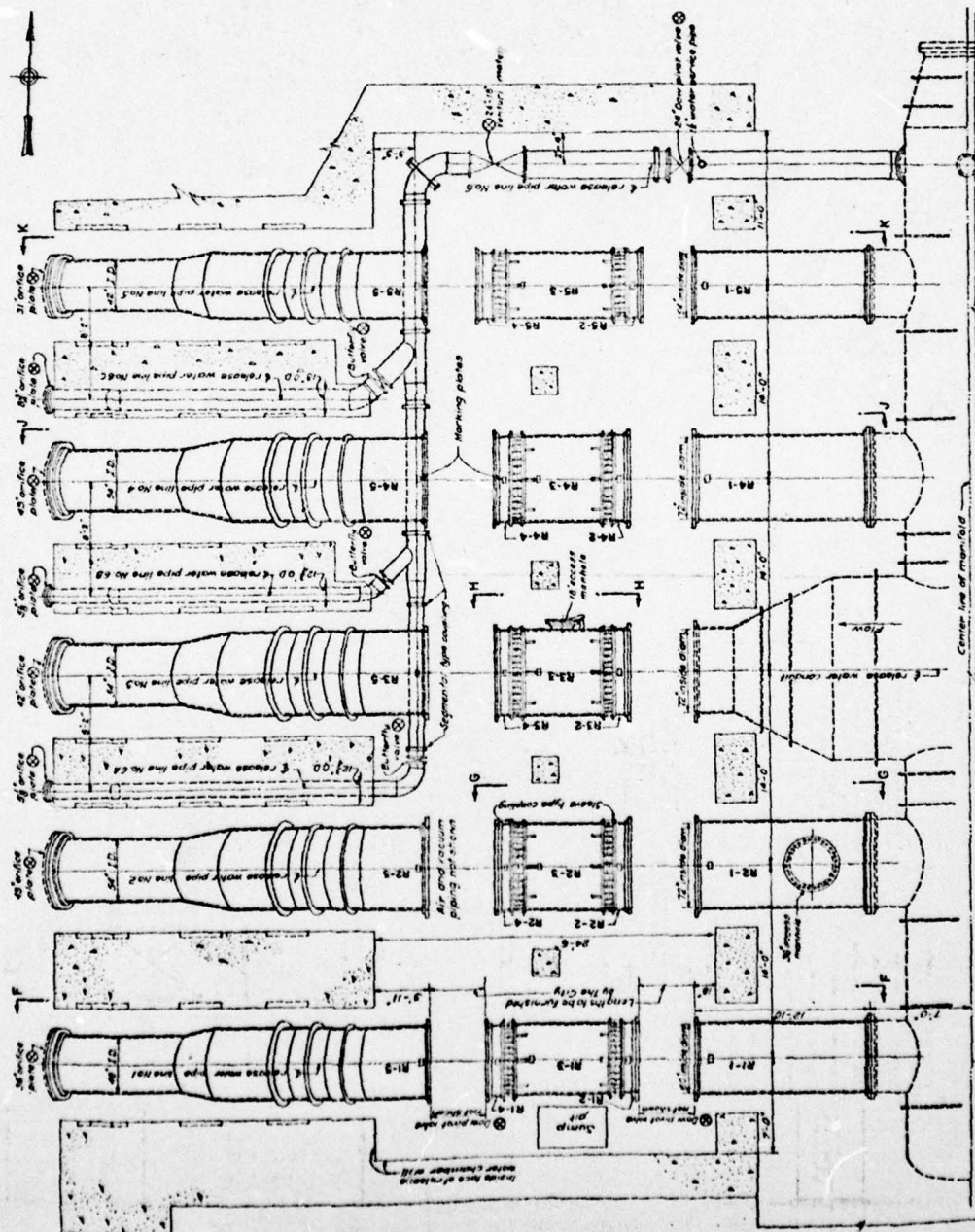
Madison, Wisconsin  
June 10, 1892







STILLING POOL



See general notes and references on sheet 107.  
Acc. 8136  
For details of pipe and fittings see sheet 107.  
For details of release water pipe line No. 6 & 8 & 10  
and 12 see sheet 107. Acc. 8136  
For details of release water pipe line No. 11  
see sheet 107. Acc. 8136  
14 and 15 shall be grooved, the ends of 12 grooved,  
gasket grooves and 10 and 11 see sheet 107. Acc. 8136

City of New York  
BOARD OF WATER SUPPLY  
CANNONVILLE DAM  
RELEASE WATER WORKS  
RELEASE WATER PIPES  
PLAN

1 2 3 4 5 6 7 8 9 10  
FEBRUARY 15, 1905  
FILED 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

PLAN OF RELEASE WATER PIPES

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City of New York  
Board of Water Supply  
Cannonville Dam  
Release Water Pipes  
Plan

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**APPENDIX F**  
**VISUAL CHECK LIST**

CHECK LIST  
VISUAL INSPECTION  
PHASE 1

NAME DAM Cannonsville Dam COUNTY Delaware STATE New York ID# 542  
TYPE OF DAM Earthfill HAZARD CATEGORY High  
DATE(s) INSPECTION June 13, 1978 WEATHER cloudy, cool TEMPERATURE 60°

POOL ELEVATION AT TIME OF INSPECTION 1,150.5 M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - LRK Kevin Cloonan - New York City Water Supply - Division Engineer  
James T. Hockensmith - LRK Jack Kane - NYCWS - Assistant Division Engineer  
John Barlow - NYCWS Supt.

James T. Hockensmith RECORDER



# EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None noted	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Appears good. Checked settlement plates - maximum settlement between 1968-1978 = .08 ft.	
RIPRAP FAILURES	None noted	

# EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Left abutment good, Right abutment downstream has some wet areas - may be influenced by hillside. springs and surface drainage.	
ANY NOTICEABLE SEEPAGE	None noted	
STAFF GAGE AND RECORDER	None noted	
DRAINS	Surface runoff drain on berms-operative.	



# CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

# CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	
STAFF GAGE OF RECORDER:	N/A	



# OUTLET WORKS - Water Supply System

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATION
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Three intakes let water into West Delaware Tunnel Average Flow 170-180 mil gal/day Maximum Flow 500 mil gal/day	
INTAKE STRUCTURE	Three intakes	
OUTLET STRUCTURE	Flows into West Delaware Tunnel	
OUTLET CHANNEL	West Delaware Tunnel	
EMERGENCY GATE	None	

# UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATION:
CONCRETE WEIR	800 feet long - 2 sections on right abutment - in good condition - side channel weir.	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Rock cut side channel and exit channel. Highwall in stable condition.	
BRIDGE AND PIERS	None	



# Principal SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	One large conduit (11'-11") with 5 gated pipes branching off and discharging into stilling basin at toe.	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Wide and clear - West Branch Delaware River	
BRIDGE AND PIERS	Two bridges but should not have any blocking effect.	
GATES AND OPERATION EQUIPMENT	Two valves on each exit pipe.	

# DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Wide and flat with few obstructions - West Branch Delaware River	
SLOPES	Flat on floodplain - steep hillsides - stable	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 100 homes -400 people	



# RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Apparently stable	
SEDIMENTATION	Minor	

## INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None known	
OBSERVATION WELLS	None known	
WEIRS	None known	
PIEZOMETERS	None known	
OTHER SETTLEMENT PLATES	Approximatley 10 - maximum settlement period 1968 - 1978 - .08 feet	



APPENDIX G

ENGINEERING DATA CHECK LIST

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
PHASE I

NAME OF DAM Cannonsville Dam

ID# 542

ITEM

REMARKS

AS-BUILT DRAWINGS

Contract Drawings Specifications

New York City Water Supply  
New York City Board of Water Supply  
(owner)

REGIONAL VICINITY MAP

Contract Drawing

Owner

CONSTRUCTION HISTORY

Application for the construction of  
a dam

New York State Department of  
Environmental Conservation

TYPICAL SECTIONS OF DAM

Contract Drawings

Owner

OUTLETS - PLAN

- DETAILS
- CONSTRAINTS
- DISCHARGE RATINGS

Contract Drawings

Owner

Unknown  
Chart

Owner  
Owner

RAINFALL/RESERVOIR RECORDS

U.S.G.S. gaging station at reservoir  
discharge

U.S.G.S.  
Owner



ITEM	REMARKS
DESIGN REPORTS	Unknown
GEOLOGY REPORTS	Unknown
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Unknown
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Owner
POST-CONSTRUCTION SURVEYS OF DAM	Unknown
BORROW SOURCES	Construction Drawings
	Owner

# REMARKS

## ITEM

### MONITORING SYSTEMS

Settlement plates

Owner

### MODIFICATIONS

None known

### HIGH POOL RECORDS

Daily strip charts

Owner

### POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS

Unknown

### PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS

None

### MAINTENANCE OPERATION RECORDS

Monthly reports

Owner



REMARKS

SPILLWAY PLAN	Contract Drawings	Owner
SECTIONS	Contract Drawings	Owner
DETAILS	Contract Drawings	Owner
OPERATING EQUIPMENT PLANS & DETAILS	Contract Drawings	Owner

CHECK LIST  
HYDROLOGIC AND HYDRAULIC  
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Mostly wooded - 450 square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1,150' - 300,000 Acre-feet

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1,175.0' - 450,000 acre-feet

ELEVATION MAXIMUM DESIGN POOL: 1,171.5'

ELEVATION TOP DAM: 1,175.0'

CREST:

- a. Elevation 1,150.0' and 1,158.07'
- b. Type uncontrolled ogee (lower) and broad crested weir
- c. Width variable
- d. Length 240 feet plus 560 feet
- e. Location Spillover right abutment
- f. Number and Type of Gates none

OUTLET WORKS:

- |                                   | <u>Water Supply System</u>               | <u>Principal Spillway</u>           |
|-----------------------------------|--|-------------------------------------|
| a. Type                           | <u>3 intakes to West Delaware Tunnel</u> | <u>11'-11" tunnel &amp; 5 pipes</u> |
| b. Location                       | <u>7 miles upstream of dam</u>           | <u>near left abutment</u>           |
| c. Entrance inverts               | <u>unknown</u>                           | <u>1,007.24</u>                     |
| d. Exit inverts                   | <u>unknown</u>                           | <u>997.0 ±</u>                      |
| e. Emergency draindown facilities | <u>Yes</u>                               | <u>Yes</u>                          |

HYDROMETEOROLOGICAL GAGES:

- a. Type U.S.G.S. gaging station - pool level recording
- b. Location downstream
- c. Records daily

MAXIMUM NON-DAMAGING DISCHARGE Approximately 12,500 cfs.